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REPORT ON
GEOTECHNICAL STUDIES FOR
PROPOSED IMPROVEMENTS TO
REACH E SEAWALL
ROUGHANS POINT
REVERE, MASSACHUSETTS

by

Haley & Aldrich, Inc.
Cambridge, Massachusetts

for

Department of the Army
New England Division
Corps of Engineers
Waltham, Massachusetts

File No. 10259-01

February 1990



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2 March 1990
File No. 10259-01

Department of the Army
New England Division
Corps of Engineers
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Waltham, Massachusetts 02254-9149

Attention: Mr. Anthony F. Mancini
Chief, Geotechnical Engineering Branch

Subject: Geotechnical Studies
Roughans Point
Revere, Massachusetts

Gentlemen:

We are pleased to submit ten copies of our report on geotechnical studies of the proposed improvements at Roughans Point, Revere, Massachusetts. This work was performed in accordance with our Contract No. DACW33-89-D-004 dated 13 July 1989, and our proposal dated 20 October 1989.

We appreciate the opportunity to work with you on this project. Please call us if you have any questions or need additional information. We look forward to assisting you on future projects.

Sincerely yours,
HALEY & ALDRICH, INC.

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I. INTRODUCTION

1-01. SITE LOCATION

This report presents the results of geotechnical studies for the proposed improvements to the existing seawall at Roughans Point, Revere, Massachusetts. The general location of the site is shown in Figure 1 - Project Locust, and Figure 2 - Exploration Location Plan and Profile. The site presently consists of a seawall approximately 1700 ft. long bordered by the Broad Sound shore to the east, and houses along Broad Sound Avenue to the west. This area is identified as Reach E by the U.S. Army Corps of Engineers (USACE).

1-02. PROJECT DESCRIPTION

The USACE has proposed improvements to the existing seawall, consisting of stone berms, stone revetments, and a concrete cap to reduce overtopping of the existing seawall. An earth berm and sand bags are proposed for backwater protection, and a gravity drain and a sluice gate to control interior drainage. The proposed improvements to the seawall and the revetment as designed by the USACE are shown in Figure 3 - USACE Proposed Seawall/Revetment Improvements. In general, the proposed revetment consists of 11 ft. of stone backfill extending horizontally 25 ft. east of the existing seawall. The revetment then is sloped at approximately 3H:1V to the existing ground surface. A toe berm detail is included to reduce scour.

1-03. SCOPE OF INVESTIGATION

The primary purpose of this study was to investigate subsurface soil conditions at the site, and to investigate the potential effects of the proposed seawall improvements and revetment construction. The general scope of services developed by the USACE and amended by our 20 October 1989 proposal for the geotechnical studies is as follows:

- o Review of previous Government studies furnished by the USACE.
- o Soil explorations consisting of 5 test borings and 5 test pits.
- o Laboratory testing of selected soil samples.



- o Assessment of the existing wall stability and condition.
- o Assessment of the affects of the proposed construction on the stability of the wall.
- o Assessment of the potential settlement of the wall, the adjacent ground and the two closest structures.
- o Recommendations for potential wall modifications to facilitate the proposed construction.

The scope of services is limited to consideration of the existing seawall, the proposed improvements to the seawall, the construction of the proposed revetment, and the two closest structures.

These studies were conducted in accordance with the original scope of work prepared by the USACE dated 29 September 1989, the Haley & Aldrich, Inc. (H&A) proposal dated 20 October 1989, and the no cost change order dated 14 December 1989.

1-04. QUALITY CONTROL

The geotechnical studies in this report were conducted in accordance with generally accepted engineering procedures. Field exploration and testing, laboratory testing, and engineering analyses were conducted and reviewed by qualified and experienced personnel. H&A field procedures were reviewed by various USACE personnel during periodic field visits.



II. SITE CONDITIONS

2-01. EXISTING CONDITIONS

The seawall consists of cantilevered steel sheet piling, embedded in the underlying soils, faced with concrete where it is exposed above grade. The exposed concrete wall varies in height from approximately 4 ft. on the west side to 15 ft. on the east side of the wall. The top of the concrete cap is approximately El. 17.6*, based on six spot elevations determined as part of this study along the length of the wall. A former pier and a breakwater are located at the north end of Reach E. The wall abuts an MDC seawall adjacent to Winthrop Parkway at the south end of the reach.

The site is bordered to the west by homes and Broad Sound Avenue. The existing grade slopes downward from the wall backfill at approximately El. 13.5 toward Broad Sound Avenue. Broad Sound Avenue slopes from El. 15 to El. 4, from south to north, but is generally below El. 5 for the length of the reach. The east side of the site is bordered by the Broad Sound.

The tides vary from mean high water at El. 4.9 to mean low water at El. -4.6, exposing the previously placed riprap boulders and sandy beach at low tide. The wall has been overtopped during coastal storms and severe flooding of the inland has occurred, as during the 1978 storm of record.

2-02. PREVIOUS CONSTRUCTION

Available records provided by the USACE indicate that the wall was designed and built in 1936. Figure 4 - Approximate Cross Section of Existing Seawall shows the available information regarding the wall cross-section (Ref. 1 and 2)**. Construction in 1936 apparently consisted of driving the steel sheet piling into the underlying silty clay (Ref. 1). A concrete cap and face was subsequently formed and poured around the piling, and the wall was backfilled on both sides. The west side of the wall was backfilled to approximately El. 13.5, while riprap boulders were placed along the east side of the wall (Ref. 2).

* Elevations in this report are in feet relative to the National Geodetic Vertical Datum (NGVD).

** References are listed in Section VIII.



A narrow asphalt walkway was placed on top of the backfill on the west side of the wall.

The seawall was repaired in 1955 and 1972. Records are not available for the work conducted in 1955. Available USACE plans indicate that the concrete face was repaired and the wall was capped again in 1972. Apparently as part of the 1972 repair, a concrete lip was formed at ground level on the east side of the wall, to facilitate construction of the new concrete face. Although plans indicate the top of the lip was to be formed at approximately El. 0, two recently surveyed lip elevations vary from El. 3 to 4. The thickness of the riprap boulders varies also and the lip is exposed at some locations along Reach E. Observations at specific locations are discussed in Section III and Section V.



III. SUBSURFACE EXPLORATIONS

3-01. PREVIOUS BORINGS

Borings were conducted prior to the original construction of the wall (circa 1936), and again in 1987 in conjunction with the USACE Coastal Flood Protection Study. A summary of the previous explorations is shown as Subsurface Profile A-A on Figure 2, and was taken from engineering log profiles prepared by the USACE (Ref. 3).

Sixteen borings were completed for the 1936 design of the seawall. The original driller's logs are not available, but profiles are shown on Reference 1, as well as on Figure 2. These original borings are designated by the prefix MDC-36. The depth of the borings varied from approximately 21 to 44 ft.

Seven borings were conducted within Reach E for the USACE in 1987. These borings are designated on Figure 2 by the prefix FD-87. The borings were conducted by Atlantic Testing Labs, Ltd., and varied in depth from 15 to 56.5 ft.

3-02. TEST BORINGS FOR THIS STUDY

The results of the previous test borings were used to assess the general stratigraphy; however, since the previous data included only a very limited amount of classification type testing, a program of field explorations with field and laboratory testing was proposed by the USACE for this study.

The test borings for this study were conducted during the period 6 December 1989 through 26 January 1990. Five test borings (designated as B89-1 through B89-5) were drilled by Guild Drilling Co., Inc. of East Providence, Rhode Island. The boring locations and required depths were reviewed by the USACE. These explorations were monitored by H&A personnel.

The borings extended from 39 ft. (B89-1) to 61.3 ft. (B89-4) below the existing ground surface. As-drilled boring locations and ground surface elevations are shown on Figure 2 - Exploration Location Plan and Profile. The boring locations were determined in the field by H&A personnel by taping relative to existing site features. Ground surface elevations at the boring locations were surveyed by Bryant Associates of Boston, Massachusetts, relative to the benchmark at the MDC Police Station at Revere Beach. Boring logs prepared by the

drilling contractor and reviewed by H&A are included in Appendix A.

The boring logs indicate descriptions based on visual/manual procedures conducted in the field. The two letter general group symbol following the sample description is the ASTM designation which reflects additional information obtained from the laboratory tests. The field visual description has been edited for the samples tested.

All of the borings were advanced with steel casing using wet rotary techniques to clean out the casing. Casing sizes ranged from PW (5 inch) to BW (2.5 inch). Typically, PW or HW (4 inch) casing was used to advance the borehole through the surficial fill deposits, and HW casing was used below this stratum through the organic soils and the marine clay. B89-2 was completed with BW casing to advance the borehole past an obstruction encountered at approximately 30 ft. depth. The HW casing was driven through the organic and clayey soils in order to conduct field vane shear tests (FVST) and to obtain thin wall tube samples (TWTS) for laboratory soil testing. A total of six FVST's were conducted, and 10 TWTS were obtained, at locations and depths as noted in the driller's logs. Results of the FVST's are summarized on Figure 5 - Engineering Parameters of Organic and Clay Soils. The FVST results shown are corrected for vane size in accordance with ASTM D 2573, and for plasticity, as recommended by Bjerrum (Ref. 7).

In addition to the FVST's and the TWTS, standard split-spoon samples were obtained in all of the borings. The samples were generally obtained at five foot depth intervals or between the FVST's and the TWTS. The Standard Penetration tests (SPT) were performed in accordance with ASTM D1586. Standard Penetration tests were conducted during the split-spoon sampling and the hammer blows to advance the sampler each 6 in. interval were recorded.

3-03. TEST PITS

A total of five test pits were excavated as part of this study. Three test pits were excavated within the tidal zone at locations designated by the USACE to obtain samples for environmental testing. Two test pits were excavated along the seawall, primarily to expose the steel sheet piling to observe its condition.



The test pits were excavated by J. Marchese & Sons of Everett, Massachusetts, between 4 and 6 January 1990, and were logged and monitored by H&A. The test pit locations were determined in the field by H&A personnel by taping relative to existing site features. Ground surface elevations of the test pit locations were surveyed by Bryant Associates, of Boston, Massachusetts, relative to the benchmark at the MDC Police Station at Revere Beach. The test pit locations are shown on Figure 2. Test pit logs including sketches are included in Appendix B.

The three environmental test pits (TP89-1 through TP89-3) were excavated at Reach D and E during low tide. The test pits varied from 7.5 to 11 ft. below existing grade. Jar samples were obtained at 2.5 ft. intervals. Each sample was obtained with a clean stainless steel sampler, and was preserved in a jar provided by the USACE. The jar samples were kept in a cooler and delivered the same day to the USACE laboratory in Waltham, Massachusetts. Bag samples of granular soils were also obtained, and delivered to the USACE. Chain of Custody reports for the samples are included in Appendix D.

The two seawall test pits (TP89-4 and TP89-5) were excavated on 5 and 6 January 1990, to determine the approximate configuration and condition of the below grade steel sheet piling. The test pits were monitored by H&A. TP89-4 was also observed by USACE personnel.

In summary, the seawall test pits revealed that the steel sheeting is in good condition, with only surficial corrosion evident. No severe distortion or deterioration was evident at these two locations. However, different concrete wall conditions were exposed at the two test pits. A concrete block or footing was exposed below the lip of the wall at TP89-4. The concrete lip was encountered at higher elevations than was indicated on the 1972 plan of the proposed repair (Ref. 2) at both test pit locations. The elevation survey indicates the top of the lip varies from El. 3 to 4. Sketches of the conditions observed at test pits TP89-4 and TP89-5 are included in Appendix B. Bag samples of granular soils were obtained and delivered to the USACE laboratory in Waltham, Massachusetts. A block sample of the clayey peat was obtained from TP89-5 for laboratory strength and consolidation testing.

IV. LABORATORY TESTING

4-01. TEST PROGRAM AND PROCEDURES

Laboratory tests were conducted on selected samples to better define the properties of subsurface soils. The following list of tests with respective quantities was completed:

<u>Test</u>	<u>Quantity</u>
Moisture and Organic Contents	4
Particle Size Analysis	4
Specific Gravity	4
Atterberg Limits	8
Consolidation	5
Triaxial Shear (UU Test)	8

Laboratory tests were generally conducted in accordance with ASTM procedures as noted on Figure C-1 in Appendix C.

4-02. LABORATORY TEST RESULTS

The laboratory tests noted above were conducted on TWTS and one block sample taken in the organic soils and the marine clay strata. The test results are summarized in Table I, and are presented graphically on Figure 5 - Engineering Parameters of Organic and Clay Soils. Plotted results of the consolidation, triaxial shear and gradation tests are included in Appendix C.

The test results indicate similar properties to those assumed in the preliminary analyses by the USACE. One exception is the results of the consolidation and strength testing of the marine clay soils conducted for this study. These results indicate that the clay is overconsolidated, with maximum past pressures varying from approximately 9 tons per square foot (tsf) at El. -30, to 5 tsf at El. -50. The undrained shear strength of the clay from the UU tests varied from 0.7 to 1.5 tsf.

The test results for the organic soils are variable, as was previously anticipated. Laboratory classification results indicate the samples tested are organic clay or peat, with higher plasticity than determined by visual/manual procedures conducted in the field during borehole sampling. The undrained shear strength from UU tests and FVST's ranges from 0.1 to 0.6 tsf, and averages approximately 0.3 tsf after correcting for plasticity.



V. SOIL AND WATER CONDITIONS

5-01. GENERAL

Roughans Point is located to the east of Young's Hill and Beachmont, two drumlins which are characteristic of the local topography. The drumlins rise above the local salt marshes or areas filled for development. Soils typical of the glacial, marine, marsh, and beach depositional modes were all encountered in the subsurface explorations, and are discussed below.

5-02. SUBSURFACE SOIL CONDITIONS

The subsurface explorations revealed the following soil sequence, listed in order from the ground surface downward:

- o Fill
- o Beach Sands
- o Organic Soils
- o Marine Clay and Sand
- o Glacial Till

The above sequence reflects the order of occurrence of the units below ground surface, however, one or more of these units may be absent at specific locations. The various strata encountered in the test borings and test pits conducted for this study are discussed below in reverse order to reflect their sequence of deposition. A generalized subsurface profile is shown on Figure 2, which includes previous explorations as well as the borings completed for this study.

The 1989 series borings were conducted to confirm previous data, and to obtain samples for laboratory testing. The soil descriptions which follow are based on the samples and observations from the 1989 series borings. Strata thicknesses were generally determined from the 1987 and 1989 borings. The 1936 borings were used only to confirm general trends.

A. Glacial Till

Glacial till, a dense, poorly sorted sediment, was deposited by glacial ice. This material is composed of a heterogeneous mixture of mineral particles and rock fragments ranging in size from clay to boulders. The glacial till encountered at B89-1, B89-2, and B89-5 generally consists of dense to very dense silty fine sand,

with varying amounts of clay, coarse sand, gravel, cobbles and boulders. The deposit was not fully penetrated in any of these borings. The top of the glacial till was encountered at depths ranging from 29 to 49 ft. below existing ground surface.

B. Marine Clay and Sand

Following the retreat and stagnation of the glacial ice sheet, a rise in sea level inundated the area with marine water. Quantities of silt, clay and fine sand sized particles settled out of suspension to form marine deposits which blanket the site. Two sub-strata have been identified within the marine deposits, as follows:

Marine Clay: The predominant marine clay sub-strata consists of a medium to hard, yellow to gray silty clay, with frequent fine sand partings and seams, and occasional coarse to medium sand and fine gravel.

Marine Sand: The marine sand sub-unit consists of dense, gray coarse to fine sand, trace fine gravel and silt, and was encountered in B89-5 only.

The marine deposits are frequently interbedded with partings, seams and layers of the two sub-strata described above. The total thickness of the marine deposits encountered in the 1989 test borings varied from 3.5 to greater than 36.5 ft.

C. Organic Soils

Organic soils were deposited in a still water environment over the marine deposits. The organic soils are a heterogeneous and highly variable deposit, both in terms of gradation and consistency. Two sub-strata have been identified within the organic soils layer:

Organic Clay and Silt: This sub-layer consists of very soft to medium, gray organic clay and silt, with varying amounts of fibrous peat, fine sand, occasional gravel, shells and other organic matter. The organic clay and silt encountered in the 1987 and 1989 series borings varied in thickness from 0 to 23.5 ft. and with an average thickness of approximately 6 ft.

Peat: This deposit consists of very soft to stiff, brown to black, clayey to fibrous peat, with varying amounts of organic silt, shells, wood and other organic

matter. The peat thickness encountered in the 1987 and 1989 series borings varied from 0 to 14 ft. with an average thickness of approximately 5 ft.

D. Beach Sands

These granular deposits were generally encountered overlying the organic soils. They consist of medium dense, coarse to fine sand, with varying amounts of silt, gravel, and occasional cobbles. Beach sands were encountered at the test pits, and at borings B89-1, B89-4, and in B89-5. The observed thicknesses varied from 1.5 to 6.8 ft.

E. Fill

The fill overlying the site was encountered in B89-1 through B89-5. The three borings drilled on the west side of the seawall encountered the backfill placed following construction of the wall. The observed backfill ranges from loose to very dense coarse to fine sand, with clay, silt, gravel, cobbles and boulders in varying amounts, to medium to hard silty clay, with sand and gravel. Occasional construction debris, consisting of concrete, asphalt, crushed stone, and glass was also encountered. The range in SPT "N" value and difficult drilling conditions may be more a result of the cobble or boulder content of the fill, than the actual density or consistency of the backfill.

The riprap fill encountered on the east side of the wall consists of sub-angular to sub-rounded boulders ranging in size from approximately 1 to 6 ft. diameter. Approximately 4 ft. of riprap was encountered in B89-2 and B89-4. Soil fill was also encountered below the riprap in B89-2, generally consisting of boulders and concrete fragments, possibly intermixed with former beach deposits, and totalling 3 ft. thick.

VI. ENGINEERING ANALYSES AND RECOMMENDATIONS

6-01. BACKGROUND

This study includes engineering analyses of previous calculations completed by the USACE; assessment of wall and slope stability, and settlement; recommendations of possible modifications to the existing wall; and discussion of construction considerations. These analyses are based on available historic data regarding wall design and subsequent repairs, the current information provided by the USACE with regard to the proposed construction, and the results of the field and laboratory investigations performed for this study.

It has been assumed that the original construction and 1972 repairs were generally completed in accordance with the available plans and profiles. Although historic construction records are not available, observations of the existing conditions of the exposed seawall and in the seawall test pits generally support this assumption with the exception of the elevation of the lip on the face of the seawall.

Additionally, the analyses were based on field and laboratory tests of samples taken at 5 locations over the 1700 ft. length of seawall. As was previously discussed, the shear strength and consolidation characteristics of the organic soils are highly variable. H&A analyzed the stability and settlement issues to evaluate several cases, based on the observed range of field and laboratory results.

6-02. PRELIMINARY ANALYSES

H&A reviewed the preliminary settlement, stability and downdrag analyses completed by the USACE, and provided to H&A. The preliminary USACE analysis was performed using soil strength and compressibility properties estimated using SPT "N" values, classification tests, and empirical relationships.

The H&A analysis of the seawall and berms is consistent with those presented in the calculations, in terms of applied loads and soils stratigraphy. The H&A analyses of settlement, stability and downdrag differ primarily as a result of additional information obtained from the field and laboratory tests. Detailed discussion of the analyses follow.

6-03. STABILITY ANALYSES

Stability analyses were completed to assess the existing condition of the seawall, as well as the potential effects of the proposed construction. Details of the proposed construction sequencing and the final seawall and revetment geometry were provided by the USACE. It is understood that the design life of this structure may be 50 to 100 years, with periodic maintenance. The issues addressed include the stability of the seawall as a retaining structure, and the slope stability of the subsurface soils during excavation and construction of the proposed revetment.

A. Wall Stability

Based on the available information, the seawall appears to be stable in its present condition. Based on spot elevations at exploration locations, the top of the concrete cap appears level, indicating minimal differential settlement at least since the 1972 repair. Surveyed elevations at the 6 locations vary from El. 17.47 to 17.70. As previously discussed, the steel sheet piling is in good condition at the two locations exposed by test pits TP89-4 and TP89-5.

The concrete portion of the seawall has many closed cracks. The cracks, observed by H&A and the USACE personnel during field visits, are frequent along the length of the reach. They are generally vertical, closed to approximately 1/16 in. width and from 4 to 10 ft. long. There is generally no visible spalling or deterioration of the concrete.

The structural stability of the wall was evaluated for the construction condition requiring excavation to El. -1, prior to placement of the proposed revetment. The analysis was performed using lateral soil pressures without any surcharge loading on either side of the wall. The stratigraphy was varied to consider the average depth of organic soils typical of most of the reach, as well as the thicker stratum observed at boreholes B89-4 and B89-5.

Results of a plane strain analysis of the cantilevered steel section without consideration of the concrete indicate that the wall would be stressed to approximately 40 to 44 kips per square inch (ksi) if long span excavations are opened in front of the wall. These results are based on a range of shear strengths for the organic soils from 0.15 to 0.45 tsf. It is anticipated that the



yield strength of the steel sheet piling is 36 ksi. Therefore, this analysis indicates that overstressing of the steel sheet piling could occur.

Figure E-1 in Appendix E illustrates the general section considered and the results obtained. Further, the point of maximum stress is below the concrete section of the wall, reducing the beneficial effects of its added stiffness in the plane strain condition. As will be discussed in more detail in Section 6-06, a staged construction sequence of shorter excavated spans would reduce the bending stresses in the wall.

B. Slope Stability

The stability of the subsurface soils was evaluated for support of the proposed revetment during construction and upon completion. The analyses were based on the configuration of the proposed revetment and the construction sequence described by the USACE as shown on plans which were provided (Ref. 4). Slope stability analyses were performed using the Geoslope computer program which assumes plane strain conditions.

Soil stratigraphy and strength characteristics were developed from the subsurface explorations and the field and laboratory test results. Several cases were considered, due to the strength variability of the soils tested. A general profile was used to check for deep or shallow failure surfaces. In general, thickness of the organic soils stratum was not a controlling factor.

It is understood that USACE requires a minimal factor of safety of 1.4 for the final construction case. During construction, a minimal factor of safety of 1.3 is required.

The H&A slope stability analyses indicate that although the revetment should be stable in the final condition, the proposed construction of a working berm, during and immediately after excavation of the toe berm creates a potentially unstable condition. The slope stability decreases with lower soil strength and higher construction surcharge loading. The stability was analyzed for a range of shear strengths in the organic soils, with varied surcharge loads. The results of this analysis are plotted on Figure 6 - Summary of Stability Analyses, Construction Case. Plotted results of the Geoslope analyses are included in Appendix E.

The USACE has indicated that a high strength geotextile may be included in the revetment design for purposes of soil segregation and reinforcement. For areas where the shear strength of the organic soils is less than 0.25 tsf, the H&A analyses indicate the slope would be unstable without a geotextile. Locally unstable areas may be stabilized using a relatively high strength geotextile. Alternative construction sequencing, such as limiting the width of the toe berm excavation parallel to the existing wall or excavation of the toe berm prior to placing the working berm, may be options for improving the stability of the slope during construction.

6-04. SETTLEMENT

Settlement of the seawall, the proposed revetment, and the adjacent areas was evaluated as a result of the increased loads due to the proposed improvements. The total settlement, resulting from initial elastic, primary consolidation and secondary compression, was evaluated at several locations for the final constructed condition.

Analysis of one-dimensional primary consolidation was performed using the TCON computer program. Elastic and secondary analyses were performed by hand calculation. The compressibility parameters were determined from laboratory tests. The laboratory values were compared to additional field and laboratory data from H&A files. The soil profiles were varied to consider both extreme and average conditions, as observed in the subsurface explorations. The estimates of ground settlement neglect the presence of the steel sheet piling.

A. Revetment

It is anticipated that the settlement of the proposed revetment will be highly variable, based on the heterogeneous nature of the organic soils. The average elastic and primary consolidation settlement at the crest of the completed structure is estimated to vary from 3 to 6 ft., and average approximately 4 ft. The average time for completion of primary consolidation is estimated to be 8 to 12 years. Secondary settlement is estimated to average 2 ft., and may occur over the next approximately 50 years following the completion of primary consolidation. Profiles and plotted results of the settlement analyses are included in Appendix F. The profiles shown in Appendix F considered an average case for the Reach E, and two extreme conditions of thicker organic deposits.



Settlement is expected to be negligible at the extreme north end of the reach, where no organic soils were encountered at borehole B89-1.

B. Seawall

The settlement of the seawall, due to downdrag loads imposed by settlement of the adjacent soils, was addressed with a historical perspective of previous construction and ground movement. Based on the current technical understanding of the downdrag phenomenon (Ref. 5 and 6), the magnitude of the downdrag forces is a function of the relative movement between the soil and the steel sheeting, as well as the effective soil stress and the shear strength of the soil. Review of previous case studies discussed in technical literature indicates that maximum soil-pile adhesion is developed with relatively small differential movements (less than 0.25 in.). Additionally, the upper limit cannot exceed the structural capacity of the pile, or the frictional resistance of the soil. If either of the two are exceeded, the pile will move downward relative to the soil, resulting in unloading of the downdrag forces, until equilibrium is achieved.

Analysis of the previous construction indicates that the wall backfill and riprap caused sufficient settlement to generate maximum downdrag forces on the steel sheet piles. The previous loads have apparently reached equilibrium, based on the wall performance since 1972. The proposed revetment will cause additional ground settlement, as noted above, and downdrag loads on the wall. The wall will therefore undergo incremental loading and yielding to maintain equilibrium. The maximum wall movement will be less than the settlement of the adjacent ground (estimated to be up to 10 inches of primary consolidation settlement at the seawall) and will probably average approximately 4 to 8 inches. Maximum downdrag force conditions will occur during primary consolidation, and will not be significantly changed by secondary compression.

C. Adjacent Structures

The two structures located closest to the wall, 11 and 12 ft. west, respectively, are at 90 Broad Sound Avenue and 7 - 9 Coral Street. Settlement estimates were made for the ground adjacent to these residential structures to assess the potential effects of the proposed construction. Records of foundation construction were not available for these two structures; although, it appears that the structures are supported by either shallow spread footings or timber piles.

Estimates of ground settlement at 10 feet west of the seawall do not exceed approximately 2 inches. Differential settlement on the order of 2 inches would cause cosmetic damage to each structure, and possible structural damage if significant previous settlement has occurred.

The masonry structure at 90 Broad Sound Ave. already exhibits numerous cracks which indicate previous differential settlement of its foundation. According to discussions with USACE personnel, they have data concerning the cracks in this structure. No apparent cracks were observed during this study in the wood frame structure at Coral Street.

6-05. WALL MODIFICATIONS

Based on the H&A field observations and engineering analyses, it appears that the wall is stable in its present condition. The proposed construction will exert additional forces on the wall due to the excavation for construction and subsequent backfilling and construction of the revetment. Impacts of the construction are considered in Section 6.06.

It is understood that the USACE has performed a cost/benefit ratio study as part of the consideration of capping the existing seawall. The objective of the cap is to increase flood protection. Additionally it may be possible to raise the wall height to account for settlement due to the proposed revetment. The settlement estimates in this report should be incorporated into the USACE design consideration of the cap height.

If the final design includes capping the wall, consideration should be given to the use of pre-cast concrete elements that could be set in place on top of the existing wall and pinned to the existing structure. A cap of pre-cast units could be less expensive than a cast-in-place cap. Also, due to the limited access, the pre-cast cap could be built from the sea side of the wall if necessary.

The existing concrete lip at the base of the wall should be removed as part of the improvement to reduce the effects of the final construction. The backfill for the proposed revetment will exert vertical loads on the wall when the underlying soils consolidate. The magnitude of these loads can be reduced by removing the lip. The previously described analyses assumed that the lip would be removed.

For budgetary purposes, the cost for cutting off the lip is estimated to be approximately \$60 per lineal foot, as indicated by local contractors. This cost reflects the geometry observed at the two test pit locations along the wall, a 3 to 4 hour daily work window to account for tidal fluctuations, and access to the lip provided by the excavation contractor. The estimated cost, which does not include general contractor overhead factor or subcontractor mark up, should be verified during the final design cost estimate.

As discussed with the USACE, vertical joints cut into the wall to reduce cracks are not recommended. Joints for that purpose must extend to approximately 3/4 through the thickness of the wall be effective. Joints may be more detrimental by exposing the steel and concrete to corrosive elements.

6-06. CONSTRUCTION CONSIDERATIONS

A. General

This section provides general comments on construction considerations and foundation treatment. This section is written primarily for the engineer having responsibility for preparation of plans and specifications. Since it identifies potential construction problems related to the seawall and earthwork, it may also aid the personnel who monitor the construction activity.

Prospective contractors for the project should evaluate potential construction problems on the basis of their own knowledge and experience, taking into account their proposed construction methods and procedures.

Excavation activities and lateral earth support (if required) for the construction should conform to the requirements of OSHA and all other applicable federal, municipal, and state regulatory agencies.

B. Excavation and Lateral Earth Support Requirements

The construction of the proposed revetment was evaluated for the construction sequence proposed by the USACE, and for the general range of subsurface conditions and laboratory test results obtained for this study (Ref. 4). It is understood that the preliminary USACE construction sequence consists of excavating to approximately El. -1 along the face of the existing seawall, placement of a high strength geotextile, and backfilling to approximately

El. 6 to create a working berm. The working berm will be constructed prior to excavation for the toe berm. As discussed in the stability analysis section of this report, the proposed revetment sequence may be unstable at various stages of construction in some areas.

To best utilize the knowledge and expertise of the contractor, the contractor should propose excavation and backfill schedules and sequences, together with supporting design calculations for review. The contractor's design should consider the variable nature of the subsurface soils, potential effects of surcharge loads appropriate for the proposed equipment, and other factors.

C. Protection of Adjacent Structures

As previously discussed, the proposed construction may lead to instability of the existing seawall, and may also impact the structures adjacent to the seawall. Therefore, care must be taken by the contractor to minimize any adverse effects on these existing structures. It is recommended that an observational approach be taken to the construction sequencing, and that the seawall and adjacent structures be monitored throughout the construction activities. Provisional corrective actions should be established so that they may be implemented if necessary, or the construction sequence may be revised to achieve the desired results.

To aid in this effort, it is recommended that a series of reference points be installed on the existing structures, seawall, and the adjacent ground for purposes of obtaining both settlement and horizontal offset data during construction. The points should be established prior to any excavation, and should be monitored regularly throughout construction, or as necessary based on an evaluation of the data obtained. A preconstruction survey of the adjacent structures is also recommended to document present condition and to identify structural deficiencies which may be of concern during the new construction.

D. Observational Approach

An observation approach should be used to monitor construction and performance of the seawall and adjacent structures. Limited reaches along the wall should be excavated and vertical and lateral wall, ground and building displacements should be surveyed.

For example, initial excavation should be limited to a maximum width of 25 ft. parallel to the wall. If corresponding wall and structure displacements are less than the acceptable criteria set by USACE, the excavated width of the next section may be increased. The contract documents should be written to provide for a conservative approach with allowances for change during construction based on demonstrated performance by the contractor and observed wall movement. The allowable width of excavation should also consider the proximity of adjacent structures.



VII. CONCLUDING COMMENTS

This report has been prepared for specific application to the subject project in accordance with generally accepted geotechnical engineering standards. No other warranty, expressed or implied is made. The studies were completed in part using available information regarding existing and proposed structures and construction procedures. In the event that changes in the design or existing conditions are encountered, the conclusions and recommendations in this report should be reviewed and the recommendations modified or verified in writing by H&A.

The recommendations are also based in part upon the data obtained from the referenced subsurface explorations. The nature and extent of the variations at and between explorations may not become evident until revealed during construction. If variations then appear evident, it will then be necessary to reevaluate the recommendations in this report.

VIII. REFERENCES

1. Massachusetts Department of Public Works drawing No. ACC. 01621-A, "Proposed Sea Wall, Roughans Point, Revere," dated October 1936.
2. USACE drawing No. SK-213, "Restoration of Sea Wall, Roughans Point," dated August 1972.
3. Engineering Log Profiles provided by the USACE, untitled, undated.
4. USACE draft "Civil Layout Plans," received 9 January 1990.
5. Baligh, Mohsen M., and Vivatrat, A Manual on Prediction of Pile Downdrag on Eng Bearing Piles. Department of Civil Engineering, Massachusetts Institute of Technology, (Cambridge, Massachusetts, 1975).
6. Fellenius, Bengt H., "Downdrag on Piles in Clay due to Negative Skin Friction," Canadian Geotechnical Journal, The National Research Council of Canada, Volume 9, No. 4, November 1972, pp. 323-337.
7. Bjerrum, Laurits, "Embankments on Soft Ground," Proceedings of the Specialty Conference on Performance of Earth and Earth-Supported Structures, Purdue University, Lafayette, Indiana, ASCE, June 1972, pp. 1-54.

0710i



HALEY & ALDRICH, INC.

**Consulting Geotechnical Engineers,
Geologists and Hydrogeologists**

TABLE I
SUMMARY OF GEOTECHNICAL LABORATORY TEST RESULTS

PAGE 1 OF 9

FILE No. 10259-01

DATE: January 1990

**PROJECT: Roughans Point
Revere, Massachusetts**

[illegible]

Refer to figure "General Geotechnical Laboratory Soil Test Program Notes" (H&A Form No.550) for definitions and test procedures, attached as figure C-1, Appendix C. Refer to Appendix C for plotted results of oedometer, triaxial and gradation tests.

H&A FORM No.502 AUG-1989

TABLE I (continued)
SUMMARY OF GEOTECHNICAL LABORATORY TEST RESULTS

HALEY & ALDRICH, INC.
Consulting Geotechnical Engineers,
Geologists and Hydrogeologists

FILE No. 10259-01
DATE: January

**PROJECT: Roughans Point
Revere, Massachusetts**

[illegible]

TABLE I (continued)
SUMMARY OF GEOTECHNICAL LABORATORY TEST RESULTS

**PROJECT: Roughans Point
Revere, Massachusetts**

[illegible]

**PROJECT: Roughans Point
Revere, Massachusetts**

[illegible]

Refer to figure "General Geotechnical Laboratory Soil Test Program Notes" (H&A Form No.550) for definitions and test procedures.

TABLE I (continued)
SUMMARY OF GEOTECHNICAL LABORATORY TEST RESULTS

**PROJECT: Roughans Point
Revere, Massachusetts**

[illegible]

TABLE I (continued)
SUMMARY OF GEOTECHNICAL LABORATORY TEST RESULTS

HALEY & ALDRICH, INC.
Consulting Geotechnical Engineers,
Geologists and Hydrogeologists

FILE NO. 10259-01
DATE: January

**PROJECT: Roughans Point
Revere, Massachusetts**

[illegible]

TABLE I (continued)

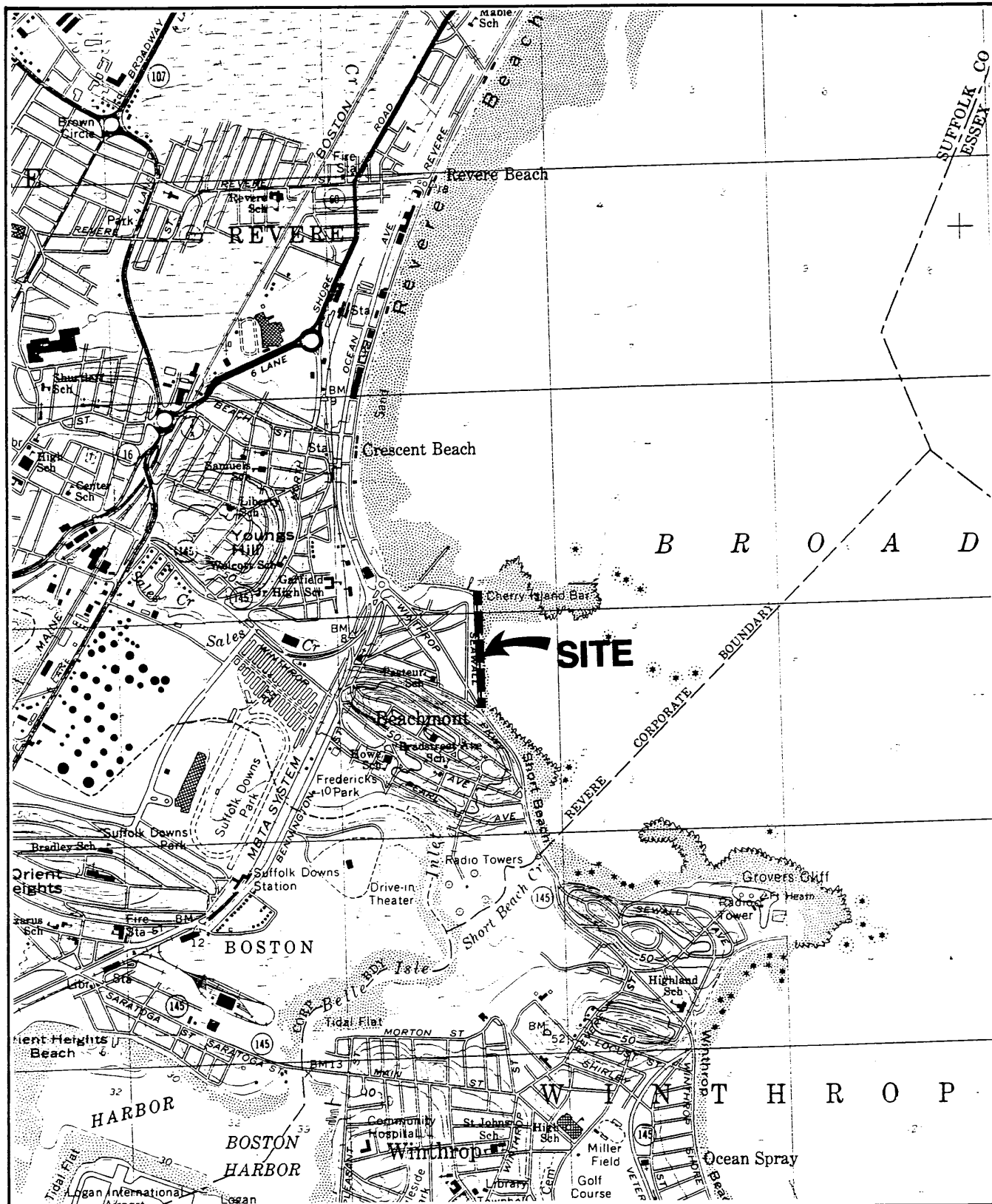
SUMMARY OF GEOTECHNICAL LABORATORY TEST RESULTS

FILE No. 10259-01

DATE: January 1990

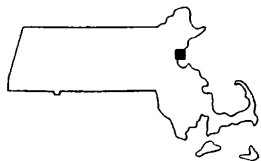
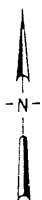
**PROJECT: Roughans Point
Revere, Massachusetts**

[illegible]



FILE NO. 10259-01 A1

SITE COORDINATES: 42°23'59"N 70°59'06"W



U.S.G.S. QUADRANGLE: LYNN, MA



Haley & Aldrich, Inc.
Consulting Geotechnical Engineers, Geologists and Hydrogeologists

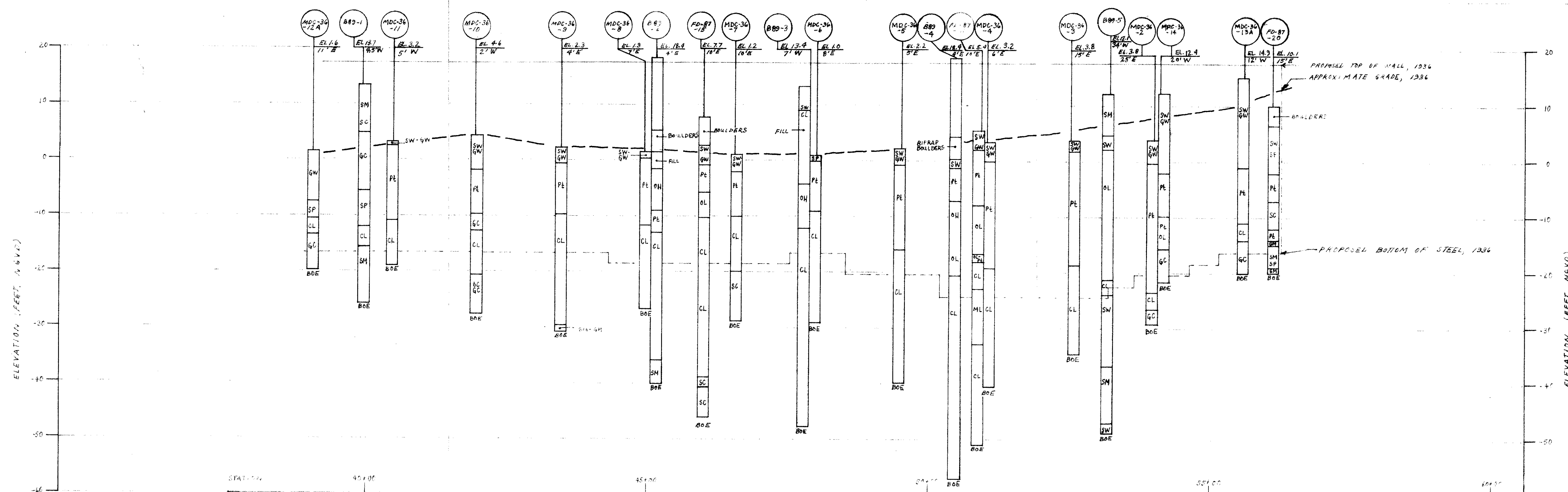
ROUGHANS POINT
REVERE, MASSACHUSETTS

PROJECT LOCUS

APPROX. SCALE 1:25,000

FEBRUARY 1990

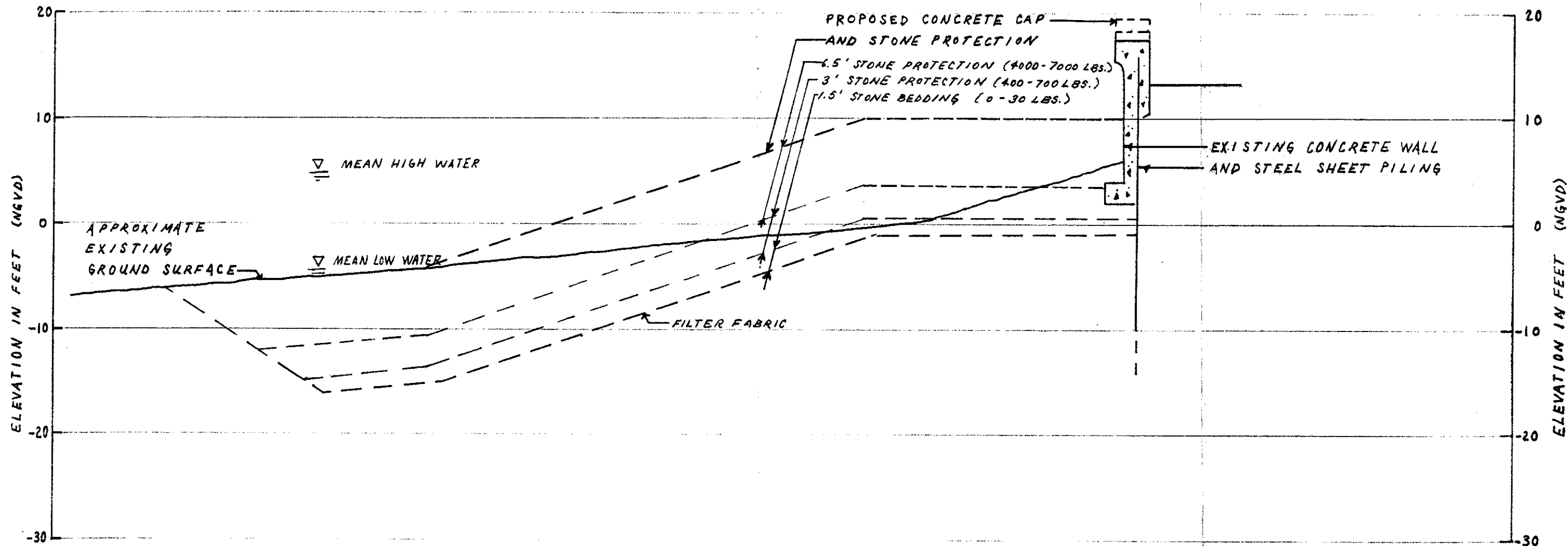
FIGURE 1



HORIZONTAL 0 100 200
VERTICAL 0 10 20
SCALE IN FEET

- NOTES:**
1. BASE PLAN FOR FIGURE 2 PREPARED FROM A USACE UNTITLED EXPLORATION PLAN, PLATE 5, SHT #7, UNDATED, (DATE OF PHOTOGRAPHY 2-7-81; CONTOUR INTERVAL 2 FT.; SCALE 1 IN. = 100 FT.).
 2. PLAN LOCATIONS OF SUBSURFACE EXPLORATIONS DESIGNATED B89-1 THROUGH B89-5 AND TP89-1 THROUGH TP89-5 WERE DETERMINED BY H&A, BY TAPING FROM EXISTING SITE FEATURES. THESE EXPLORATIONS WERE MONITORED BY H&A PERSONNEL.
 3. BORING LOGS FOR B89-1 THROUGH B89-5 MAY BE FOUND IN APPENDIX A OF THIS REPORT. TEST PIT LOGS, PLANS AND SECTIONS FOR TP89-1 THROUGH TP89-5 MAY BE FOUND IN APPENDIX B OF THIS REPORT.
 4. PROFILES AND STRATA CLASSIFICATIONS SHOWN FOR BORINGS MDC-36-2 THROUGH MDC-36-11; MDC-36-12A, MDC-36-13A, MDC-36-14; AND FD-87-15, FD-87-20, AND FD-87-21 WERE TAKEN FROM ENGINEERING LOG PROFILES PROVIDED BY THE USACE, UNTITLED, UNDATED. ADDITIONAL INFORMATION REGARDING EXISTING CONDITIONS AND PROPOSED CONSTRUCTION IN 1936 WAS TAKEN FROM A MASSACHUSETTS DPW DRAWING ENTITLED "PROPOSED SEA WALL, ROUGHNAS POINT, REVERE," CONTRACT NO. 479, DRAWING NO. ACC. 01621-A, SHEET 1 OF 3 SHEETS, DATED OCTOBER, 1936.
 5. REFER TO THE REPORT TEXT FOR A DISCUSSION OF THE SUBSURFACE CONDITIONS AND MORE DETAILED INFORMATION REGARDING SUBSURFACE EXPLORATIONS, AND APPENDICES FOR PRESENTATION OF SUBSURFACE AND TESTING DATA.
 6. ELEVATIONS ARE IN FEET AND REFER TO NATIONAL GEODETIC VERTICAL DATUM.
 7. LINES REPRESENTING CHANGES IN STRATA ARE BASED ON INTERPOLATION BETWEEN SUBSURFACE EXPLORATIONS AND MAY NOT REPRESENT ACTUAL FIELD CONDITIONS AT OTHER THAN SPECIFIC EXPLORATION LOCATIONS.

FEBRUARY 1990



NOTES:

1. TAKEN FROM DRAWING PROVIDED BY THE USACE, UNTITLED, UNDATED, SECTION AT STATION 51+00, TYPICAL SECTION FROM STA. 38+45 TO STA. 56+25, (REACH E).



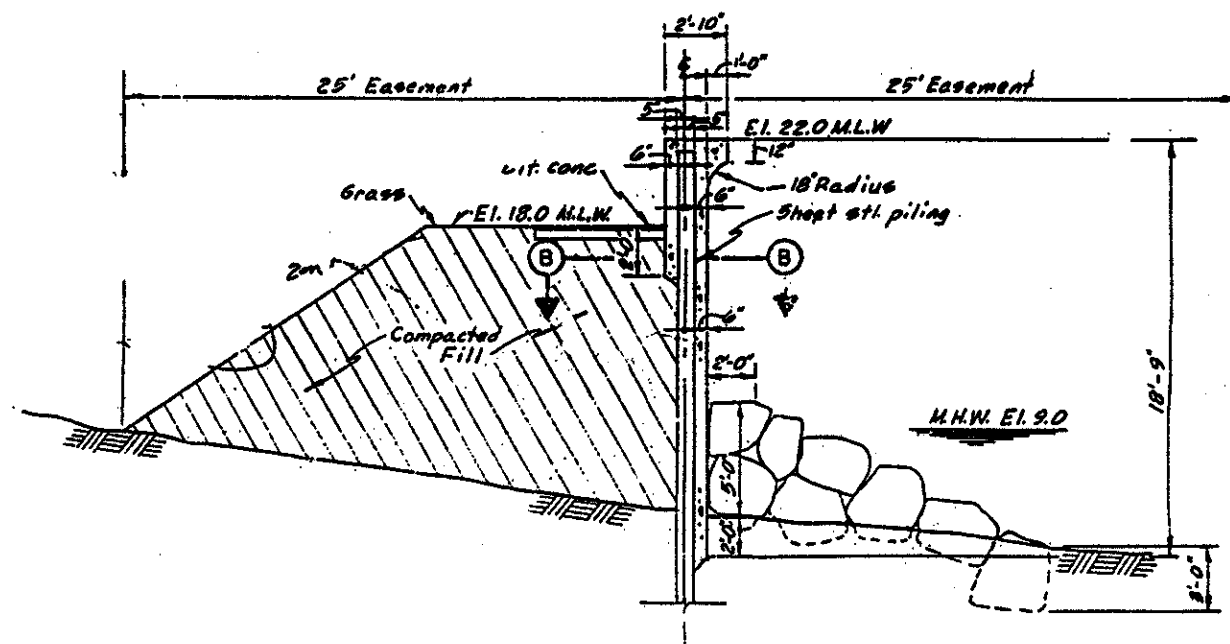
AGA Haley & Aldrich, Inc.
Consulting Geotechnical Engineers, Geologists and Hydrogeologists

ROUGHANS POINT
REVERE, MASSACHUSETTS

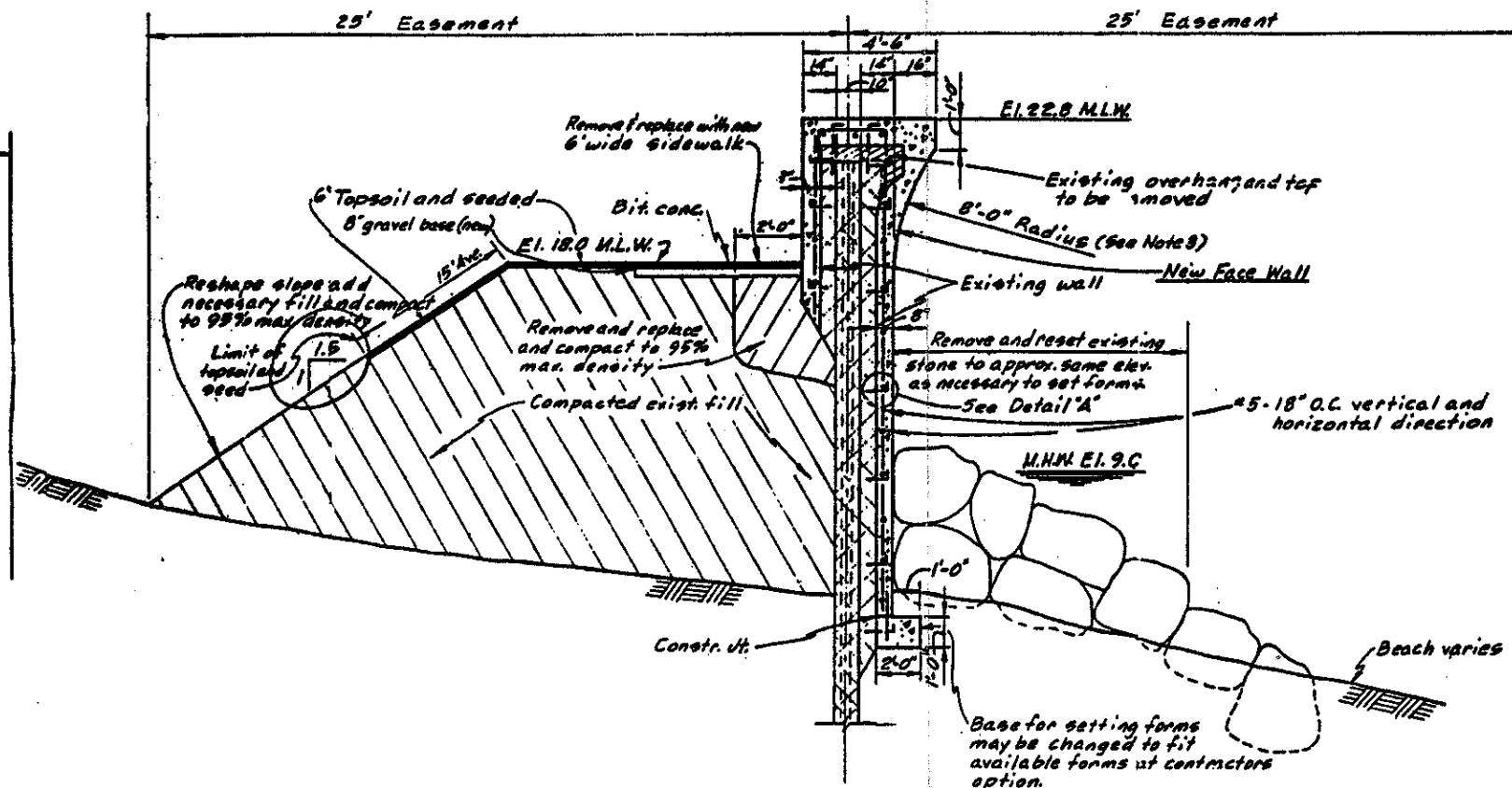
USACE PROPOSED SEAWALL/REVTMENT IMPROVEMENTS

SCALE: AS SHOWN

FEBRUARY 1990



ORIGINAL WALL SECTION
NO SCALE



RESTORATION SECTION
NO SCALE

NOTES:

1. SECTIONS TAKEN FROM USACE DRAWING NO. SK-213, SHEET 1, ENTITLED "ROUGHAN'S POINT, RESTORATION OF SEAWALL," DATED AUGUST 1972.
2. REFER TO REPORT TEXT AND APPENDICES FOR ADDITIONAL INFORMATION REGARDING EXISTING CONDITIONS.

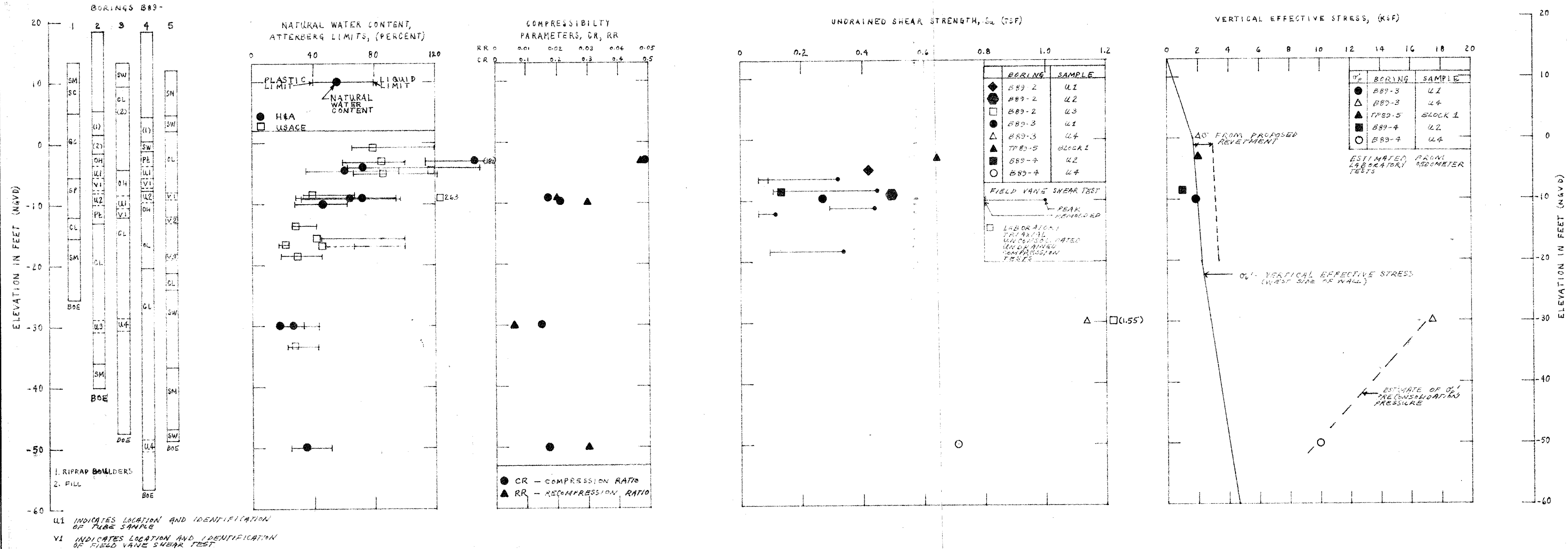
HA Haley & Aldrich, Inc.
Consulting Geotechnical Engineers, Geologists and Hydrogeologists

ROUGHAN'S POINT
REVERE, MASSACHUSETTS

APPROXIMATE CROSS SECTION
OF EXISTING SEAWALL

NOT TO SCALE

FEBRUARY 1990



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Consulting Geotechnical Engineers, Geologists and Hydrogeologists

ROUGHANS POINT
REVERE, MASSACHUSETTS

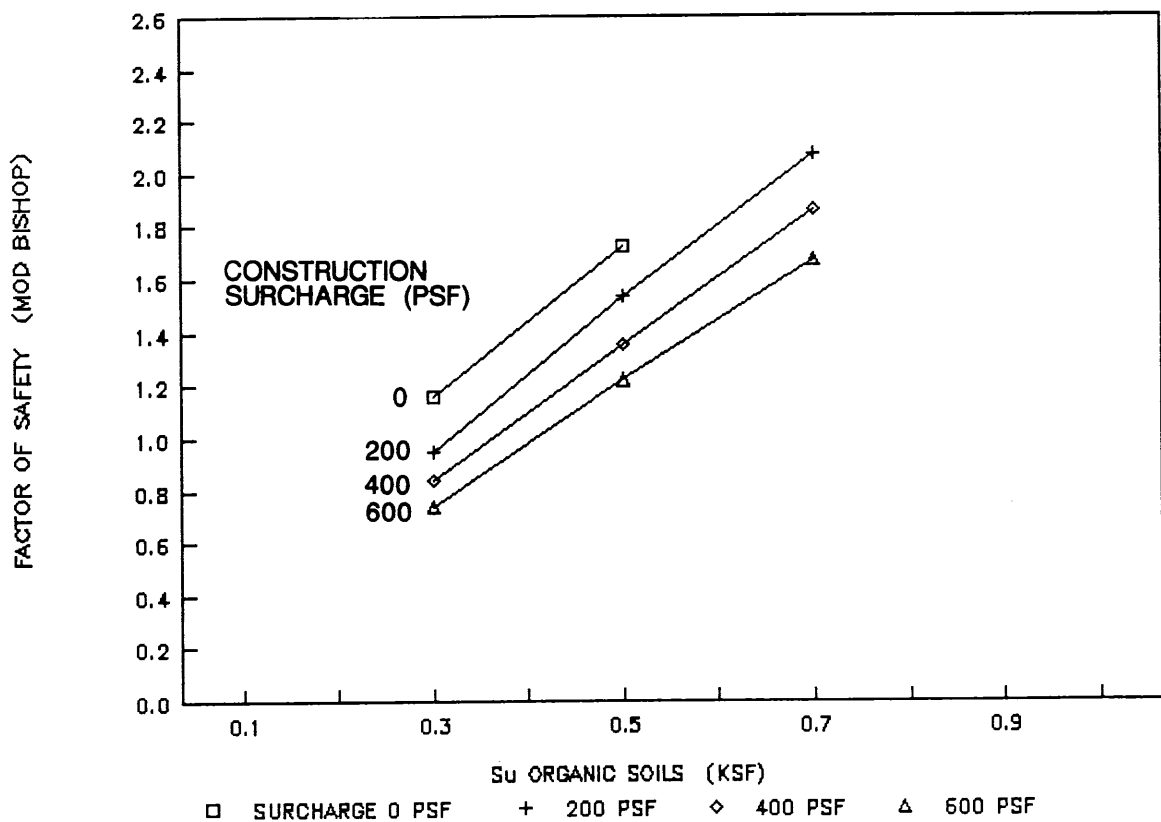
**ENGINEERING PARAMETERS OF
ORGANIC AND CLAY SOILS**

SCALE: AS SHOWN

FEBRUARY 1990

FIGURE 5

FACTOR OF SAFETY V. SHEAR STRENGTH, S_u



FILE NO. 10259-01 A6



Haley & Aldrich, Inc.
Consulting Geotechnical Engineers, Geologists and Hydrogeologists

ROUGHANS POINT
REVERE, MASSACHUSETTS

SUMMARY OF STABILITY ANALYSES CONSTRUCTION CASE

SCALE: AS SHOWN

FEBRUARY 1990

APPENDIX A
Logs of Test Borings



GUILD DRILLING CO., INC.

100 WATER STREET EAST PROVIDENCE, R. I.

TO Haley & Aldrich, Inc. ADDRESS Cambridge, Mass.
PROJECT NAME Sea Wall Improvements LOCATION Revere, Mass.
REPORT SENT TO above/Revere Beach PROJ. NO. 1025901
SAMPLES SENT TO " OUR JOB NO. 90-290

SHEET 1 OF 1
DATE _____
HOLE NO. B 89-1
LINE & STA. _____
OFFSET _____
SURF. ELEV. 13.7 NGVD

GROUND WATER OBSERVATIONS				CASING	SAMPLER	CORE BAR	Date	Time
At <u>14.0'</u>	after <u>72</u> Hours	Type	PW-HW	S/S			START	<u>12-06-89</u> a.m.
	(tidal)	Size I.D.	5" 4"	1-3/8"			COMPLETE	<u>12-11-89</u> p.m.
At _____	after _____ Hours	Hammer Wt.		140#			TOTAL HRS.	
		Hammer Fall		30"		BIT	BORING FOREMAN	<u>J. Texeira</u>
							INSPECTOR	<u>W. Rubik</u>
							SOILS ENGR.	

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler			Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE		
				From	To					No.	Pen	Rec
				0-6	6-12	12-18		0.2'	Blacktop			
		0.5'-2.5'	D	12	18	23	Dense		Gray coarse SAND, fine-med. Gravel, tr. of Silt (SM)	1	24"	2"
				26								
		4'-6'	D	3	3	4	Med. Stiff		Yellow silty CLAY mixed with fine Sand, some fine Gravel, Boulders (SC)	2	24"	10"
				8								
		9'-11'	D	2	3	11	Stiff	8.5'	Note: Water return below 8.5'			
				9					Yellow silty CLAY and coarse Gravel, tr. of fine Sand (Gc) (Fill)	3	24"	6"
		@14'	D	50	0"		Hard		Refusal on Cobble	4	0"	0"
		19'-21'	D	7	4	8	Med. Dense	18.7'		5	24"	0"
				10					Gray coarse SAND (SP)			
		24.5'-25.5'	D	6	8			25.5'		6	12"	0"
		25.5'-26.5'	D	-	23	34	Hard			6A	12"	12"
								29.0'	Yellow CLAY (CL)			
		29'-30.3'	D	71	70	100-4	" "		Brown silty fine SAND, little coarse to medium sand, gravel with cobbles and boulders (SM) (Till)	7	16"	14"
		34'-35.5'	D	14	48	54	" "			8	18"	6"
								39.0'	Note: Boulder 37.5'-39' (Refusal)			
		39'	D	50	0"				Bottom of Boring 39.0'	9	0"	0"

GROUND SURFACE TO 10.0'

USED PW

"CASING: THEN HW to 27.5 Wash & S/S to Ref

Sample Type

D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used

trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140lb Wt. x 30" fall on 2" O.D. Sampler

Cohesionless Density
0-10 Loose
10-30 Med. Dense
30-50 Dense
50+ Very Dense

Cohesive Consistency

0-4 Soft 30+ Hard
4-8 M/Stiff
8-15 Stiff
15-30 V-Stiff

SUMMARY:

Earth Boring 39.0
Rock Coring _____
Samples 9

HOLE NO. B 89-1



GUILD DRILLING CO., INC.

100 WATER STREET EAST PROVIDENCE, R. I.

TO Haley & Aldrich, Inc.

PROJECT NAME Sea Wall Improvements

REPORT SENT TO above/Revere Beach

SAMPLES SENT TO "

ADDRESS Cambridge, Mass.

LOCATION Revere, Mass.

PROJ. NO. 1025901

OUR JOB NO. 90-290

SHEET 1 OF 2

DATE _____

HOLE NO. B89-2

LINE & STA. _____

OFFSET _____

SURF. ELEV. 18.4 NGVD

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR	Date	Time
At _____ after _____ hours	Type	PW-HW	S/S		START	1/12/90 a.m.
Tidal	Size I.D.	NW	1-3/8"		COMPLETE	1/30/90 p.m.
At _____ after _____ hours	Hammer Wt.	Spin	140#	BIT	TOTAL HRS.	
	Hammer Fall		30"		BORING FOREMAN	N. Stutard
					INSPECTOR	W. Rubik
					SOILS ENGR.	

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler			Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE		
				From 0-6	To 6-12	To 12-18				No.	Pen	Rec
									Drill off Platform on Sea Wall			
								13'				
									Boulders, Rip Rap (Fill)			
								17'				
									Note: Cobbles, Gravel and Concrete (Fill)			
								20'				
		20'-21.5'	D	1	1	1	Soft		Gray Clayey Organic SILT, trace of peat (OH)	1	18"	18'
		22.3'-24.3'	UP						Gray Organic CLAY (OH)	UP1	24"	24"
									(Vane Shear Test)	V1		
		25.3'-25.8'	V									
		26.5'-28.5'	UP					28'	Gray Organic CLAY (OH)	UP2	24"	24"
		28.5'-30'	D	34	8	7	Stiff		Dark Brown PEAT (with Wood)	2	18"	9'
								31.5'	Broke off 4" Casing (PT)			
									Change noted in drive resistance of casing at 31.5'			
		35'-37'	D	10	11	12	Very stiff		Brown Silty CLAY, trace of fine sand (CL)	3	24"	18'
				16								

GROUND SURFACE TO _____

USED _____ "CASING: THEN _____

Sample Type

D=Dry C=Cored W=Washed

UP=Undisturbed Piston

TP=Test Pit A=Auger V=Vane Test

UT=Undisturbed Thinwall

Proportions Used

trace 0 to 10%

little 10 to 20%

some 20 to 35%

and 35 to 50%

140lb Wt. x 30" fall on 2" O.D. Sampler

Cohesionless Density

0-10 Loose

10-30 Med. Dense

30-50 Dense

50+ Very Dense

Cohesive Consistency

0-4 Soft 30+ Hard

4-8 M/Stiff

8-15 Stiff

15-30 V-Stiff

SUMMARY:

Earth Boring 58.5

Rock Coring _____

Samples 8

HOLE NO B89-2



GUILD DRILLING CO., INC.

100 WATER STREET EAST PROVIDENCE, R I

SHEET 2 OF 2

DATE

HOLE NO. B89-2

LINE & STA.

OFFSET

SURF. ELEV.

TO ADDRESS
PROJECT NAME LOCATION
REPORT SENT TO PROJ. NO.
SAMPLES SENT TO OUR JOB NO. 90-290

GROUND WATER OBSERVATIONS			CASING	SAMPLER	CORE BAR.	Date	Time
At	after	Hours	Type			START	
At	after	Hours	Size I.D.			COMPLETE	
			Hammer Wt.			TOTAL HRS.	
			Hammer Fall			BORING FOREMAN	
						INSPECTOR	
						SOILS ENGR.	

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler			Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE		
				From 0-6	6-12	To 12-18				No.	Pen	Rec
		40'-41.5'	D	9	14	13	Very stiff		Brown Silty CLAY, trace of fine sand (CL)	4	18"	9"
		45'-46.5'	D	6	7	11	"		Gray Silty CLAY (CL)	5	18"	18"
		47.5'-49.5'	UP							UP3	24"	21"
		49.5'-51'	D	10	7	9	"		"	6	18"	14"
		55'-56.5'	D	19	43	45	Very dense	54.5'	Gray silty fine to coarse SAND, trace gravel, clay (SM) (Till)	7	18"	10"
		58'-58.5'	D	110	5"	*20/1"	"	58.5'	(Refusal)	8	6"	0"
		Bottom of Boring 58.5'										
		(* denotes 300% Wt. on Spoon)										
		(Bottom of Hole from Platform 58.5')										

GROUND SURFACE TO

USED

"CASING: THEN

Sample Type

D=Dry C=Cored W=Washed

UP=Undisturbed Piston

TP=Test Pit A=Auger V=Vane Test

UT=Undisturbed Thinwall

Proportions Used

trace 0 to 10%

little 10 to 20%

some 20 to 35%

and 35 to 50%

140lb Wt. x 30" fall on 2" O.D. Sampler

Cohesionless Density

0-10 Loose

10-30 Med. Dense

30-50 Dense

50+ Very Dense

Cohesive Consistency

0-4 Soft 30+ Hard

4-8 M/Stiff

8-15 Stiff

15-30 V-Stiff

SUMMARY:

Earth Boring

Rock Coring

Samples

HOLE NO. B89-2



GUILD DRILLING CO., INC.

100 WATER STREET EAST PROVIDENCE, R I

TO Haley & Aldrich, Inc. ADDRESS Cambridge, Mass.
PROJECT NAME Sea Wall Improvements LOCATION Revere, Mass.
REPORT SENT TO above/Revere Beach PROJ. NO. 1025901
SAMPLES SENT TO " OUR JOB NO. 90-290

SHEET 1 OF 2
DATE _____
HOLE NO B89-3
LINE & STA. _____
OFFSET _____
SURF. ELEV. 13.4 NGVD

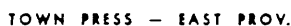
GROUND WATER OBSERVATIONS			CASING	SAMPLER	CORE BAR	Date	Time
At <u>12.5</u>	after _____ Hours	Type	<u>PW-HW</u>	<u>S/S</u>		START <u>12/15/89</u>	a.m.
(<u>tidal</u>)		Size I.D.	<u>5" 4"</u>	<u>1-3/8"</u>		COMPLETE <u>12/20/89</u>	p.m.
At _____	after _____ Hours	Hammer Wt.	<u>Drill</u>	<u>140#</u>	BIT	TOTAL HRS. _____	
		Hammer Fall	_____	<u>30"</u>		BORING FOREMAN <u>J. Texeira</u>	
						INSPECTOR <u>W. Rubik</u>	
						SOILS ENGR. _____	

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler			Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE		
				From 0-6	To 6-12	To 12-18				No.	Pen	Rec
								0.2'	Blacktop			
		0.5'-0.8'	D	100	4"		Very-Dense		Gray coarse SAND & Boulder (SW) (Fill)	1	4"	2"
		4'-6'	D	3	3	3	Medium Stiff		Olive CLAY, some fine to medium Sand, tr. of fine Gravel, tr. of Silt (Fill) (CL)	2	24"	11"
		9'-11'	D	9	21	100	6" Hard		(FILL) Sand, Silt, Clay Piece of Rubber (organic odor noted) (CL)	3	24"	7"
		@14.0'	D	50	0"		" "		Refusal on Boulder	4	0"	0"
								17.5'				
		19'-21'	D	6	4	5	Medium Stiff		Organic SILT and Shells	5	24"	0"
		22'-24'	UP						Gray Organic CLAY (OH)	U1	24"	12"
		24'-25.2'	V						(Vane Shear Test)	V1		
		26'-28'	UP					25.5'				
		28'-30'	D	8	9	11	Very-Stiff		Gray Silty CLAY (CL)	U2	24"	8"
				15					Gray Silty CLAY, trace of fine sand (CL)	6	24"	24"
		31'-33'	UP						" (CL)	U3	24"	12"
		33'-35'	D	10	12	13	Very-Stiff		" (CL)	7	24"	5"
				11								
		39'-41'	D	4	5	3/4	M.Stiff		" (CL)	8	24"	22"

GROUND SURFACE TO 10' USED PW-HW CASING: THEN to 30' S/S to Bottom

Sample Type	Proportions Used	140lb Wt. x 30" fall on 2" O.D. Sampler	SUMMARY:
D=Dry C=Cored W=Washed	trace 0 to 10%	Cohesionless Density	Earth Boring <u>61'</u>
UP=Undisturbed Piston	little 10 to 20%	0-10 Loose	Rock Coring _____
TP=Test Pit A=Auger V=Vane Test	some 20 to 35%	10-30 Med. Dense	Samples <u>12</u>
UT=Undisturbed Thinwall	and 35 to 50%	30-50 Dense	HOLE NO <u>B89-3</u>
		50+ Very Dense	
		0-4 Soft 30+ Hard	
		4-8 M/Stiff	
		8-15 Stiff	
		15-30 V-Stiff	





GUILD DRILLING CO., INC.

100 WATER STREET EAST PROVIDENCE, R. I.

SHEET 2 OF 2
DATE _____
HOLE NO. B89-4
LINE & STA. _____
OFFSET _____
SURF. ELEV. _____

TO _____ ADDRESS _____
PROJECT NAME _____ LOCATION _____
REPORT SENT TO _____ PROJ. NO. _____
SAMPLES SENT TO _____ OUR JOB NO. 90-290

GROUND WATER OBSERVATIONS		CASING	SAMPLER	CORE BAR	Date	Time
At _____	after _____ Hours	Type _____	_____	_____	START _____	a.m.
At _____	after _____ Hours	Size i.D. _____	_____	_____	COMPLETE _____	p.m.
		Hammer Wt. _____	_____	BIT _____	TOTAL HRS. _____	
		Hammer Fall _____	_____	_____	BORING FOREMAN _____	
					INSPECTOR _____	
					SOILS ENGR. _____	

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler			Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE		
				From 0-6	To 6-12	To 12-18				No.	Pen	Rec
									Gray Silty CLAY (CL)			
		44'-46'	D	5	13	13	Very Stiff		Gray Silty CLAY, trace of fine sand (CL)	5	24"	18"
				18								
		49'-50.5'	D	7	5	12	"		" (CL)	6	18"	13"
		52'-54'	UP						" (CL)	U3	24"	24"
		54'-56'	D	10	9	8	"			7	24"	18"
				6								
		59'-60.5'	D	5	6	4	Stiff		" (CL)	8	18"	18"
		64'-65.5'	D	5	5	5	"		" (CL)	9	18"	18"
		67'-69'	UP						" (CH)	U4	24"	24"
		69'-70.5'	D	4	12	11	Very Stiff		Gray CLAY, fine Sand Lenses (CL)	10	18"	18"
		74'-75.5'	D	15	16	18	Hard	75.5'	Gray Silty CLAY (CL)	11	18"	4"
									Bottom of Boring 75.5'			

GROUND SURFACE TO _____

USED _____

"CASING: THEN _____

Sample Type
D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used
trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140lb Wt. x 30" fall on 2" O.D. Sampler
Cohesionless Density
0-10 Loose
10-30 Med. Dense
30-50 Dense
50+ Very Dense
Cohesive Consistency
0-4 Soft 30+ Hard
4-8 M/Stiff
8-15 Stiff
15-30 V-Stiff

SUMMARY:
Earth Boring _____
Rock Coring _____
Samples _____
HOLE NO B89-4



GUILD DRILLING CO., INC.

100 WATER STREET EAST PROVIDENCE, R. I.

TO Haley & Aldrich, Inc. ADDRESS Cambridge, Mass.
PROJECT NAME Sea Wall Improvements LOCATION Revere, Mass.
REPORT SENT TO above/Revere Beach PROJ. NO. 1025901
SAMPLES SENT TO " OUR JOB NO. 90-290

SHEET 1 OF 2
DATE _____
HOLE NO. B89-5
LINE & STA. _____
OFFSET _____
SURF. ELEV. 12.1 NGVD

GROUND WATER OBSERVATIONS				CASING	SAMPLER	CORE BAR.	Date	Time
At <u>12.5'</u>	after <u>8</u> Hours	Type	HW-NW	S/S			START <u>12/11/89</u>	a.m.
		Size I.D.	4" 3"	1-3/8"			COMPLETE <u>12/15/89</u>	p.m.
At _____	after _____ Hours	Hammer Wt.	Spin	140#			TOTAL HRS.	
		Hammer Fall		30"		BIT	BORING FOREMAN <u>J. Texeira</u>	
							INSPECTOR <u>W. Rubik</u>	
							SOILS ENGR.	

LOCATION OF BORING:

DEPTH	Casing Blows per foot	Sample Depths From - To	Type of Sample	Blows per 6" on Sampler			Moisture Density or Consist.	Strata Change Elev.	SOIL IDENTIFICATION Remarks include color, gradation, Type of soil etc. Rock-color, type, condition, hardness, Drilling time, seams and etc.	SAMPLE		
				From 0-6	To 6-12	To 12-18				No.	Pen	Rec
		0.2'-1.5'	D	31	57	100-	Very-Dense		Blacktop - Rubble Fill, Rock Fill (SM)	1	16"	10"
				4"								
		@ 4.0'	D	50	0"		" "		Cobbles and Boulders	2	0"	0"
								7.5'				
		9'-11'	D	6	9	3	M.Dense /M.Stiff	10.0'	Gravelly Sands	3	24"	11"
				2								
		12'-14'	D	2	1	1	Soft		Organic SILT and Peat (OL)	4	24"	11"
				2								
		15'-17'	Shelby Tube						No Recovery	U1	24"	0"
		17'-19'	Shelby Tube							U2	24"	8"
		19'-20.3'	V						(Vane Shear Test)	V1		
		21'-23'	D	4	5	3	Medium Stiff		Gray Organic SILT, trace of fine sand (OL)	5	24"	16"
				1					(Vane Shear Test)	V2		
		23'-24.5'	V									
		25'-27'	Shelby Tube						No Recovery	U3	24"	0"
		27'-29'	D	WOR	1=12"	1	Soft		Gray Organic SILT, trace of fine sand (OL)	6	24"	20"
		30'-30.5'	V						(Vane Shear Test)	V3		
		34'-36'	D	2	4	4	Medium Stiff	33.5'	Gray Silty CLAY, little fine sand in seams (CL)	7	24"	22"
				6				35.9'				
		39'-41'	D	10	21	25/32	Dense		Brown coarse to fine SAND, trace of fine gravel (SW)	8	24"	6"

GROUND SURFACE TO 59' HW USED NW "CASING: THEN S/S to 61.0'

Sample Type

D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used

trace 0 to 10%
little 10 to 20%
some 20 to 35%
and 35 to 50%

140lb Wt. x 30" fall on 2" O.D. Sampler

Cohesionless Density
0-10 Loose
10-30 Med. Dense
30-50 Dense
50+ Very Dense

Cohesive Consistency

0-4 Soft 30+ Hard
4-8 M/Stiff
8-15 Stiff
15-30 V-Stiff

SUMMARY:

Earth Boring 61'
Rock Coring
Samples 12

HOLE NO B89-5

GUILD DRILLING CO., INC.

100 WATER STREET EAST PROVIDENCE, R. I.

SHEET 2 OF 2
DATE _____
HOLE NO. B89-5
LINE & STA. _____
OFFSET _____
SURF. ELEV. _____

TO _____ ADDRESS _____
PROJECT NAME _____ LOCATION _____
REPORT SENT TO _____ PROJ. NO. _____
SAMPLES SENT TO _____ OUR JOB NO. 90-290

GROUND WATER OBSERVATIONS			CASING	SAMPLER	CORE BAR.	Date	Time
At _____	after _____	Hours	Type _____	_____	_____	START _____	a.m.
			Size I D. _____	_____	_____	COMPLETE _____	p.m.
			Hammer Wt. _____	_____	_____	TOTAL HRS. _____	a.m.
At _____	after _____	Hours	Hammer Fall _____	_____	BIT _____	BORING FOREMAN _____	p.m.
				_____	_____	INSPECTOR _____	
				_____	_____	SOILS ENGR. _____	

LOCATION OF BORING:

[illegible]

GROUND SURFACE TO _____ USED _____" CASING: THEN

Sample Type
D=Dry C=Cored W=Washed
UP=Undisturbed Piston
TP=Test Pit A=Auger V=Vane Test
UT=Undisturbed Thinwall

Proportions Used	
trace	0 to 10%
little	10 to 20%
some	20 to 35%
and	35 to 50%

140lb Wt. x 30" fall on 2" O.D. Sampler		Cohesive Consistency	
Cohesionless	Density	Cohesive	Consistency
0-10	Loose	0-4	Soft
10-30	Med. Dense	4-8	M/Stiff
30-50	Dense	8-15	Stiff
50 +	Very Dense	15-30	V-Stiff

SUMMARY:
Earth Boring _____
Rock Coring _____
Samples _____

HOLE NO B89-5

APPENDIX B

Logs of Test Pits, Plans and Sections



Haley & Aldrich, Inc.

TEST PIT REPORTTEST PIT NO. 89-1FILE NO. 10259-01PROJECT ROUGHANS POINTLOCATION REVERE, MASSACHUSETTSCLIENT UNITED STATES ARMY CORPS OF ENGINEERSCONTRACTOR USED J. MARCHESE & SONSEQUIPMENT USED MITSUBISHI MS 230 LC EXCAVATORLOCATION See PlanELEVATION -0.60 NGVDEXPLORATION DATE 4 JAN 90H&A REP PELNIK/RUBIK

SCALE IN FEET	STRATA CHANGE	SAMPLE NUMBER	SAMPLE DEPTH RANGE	DESCRIPTION OF MATERIALS	REMARKS
2	0.4	S1 S1A	0-2.5	Gray mostly fine SAND, little coarse to fine, subrounded to subangular gravel, subrounded cobbles, 3 to 8 in. diameter, subangular bounders, 18-in. diameter, SP	Water entering test pit at 2- ft. depth, flowing from west.
4	3.0	S2 S2A	2.5-5	Gray to black, mostly coarse to fine, subrounded to subangular Gravel, some coarse to fine sand, little subrounded cobbles, 3 to 8 in. diameter, with 8 to 18-in. diameter boulders, trace organic silt, GW.	Noted organic or petroleum odor in black layer from 2 to 3- ft. depth.
6		S3 S3A	5-7.5	Gray, mostly organic SILT, some clay, trace shells and brown peat fibers, OL. No dilatance, low plasticity and toughness. Organic odor	Su varied from 0.2 to 0.5 kg/cm ² by torvane.
8	7.7	S4 S4A	7.5-10	Occasional layers of silty fine sand from 5.5 to 5.8-ft. depth, 1/16 to 1/2 in. thick.	Pit walls stable in cohesive soils.
10				Gray to brown silty CLAY, CL/ML. Mostly clay, some silt, trace brown peat fibers, no dilatancy, medium plasticity and toughness.	
				Occasionally stratified with layers of fine SAND, 1/16 to 1/2 in. thick.	
				Bottom of Exploration at 10.0 ft. depth. All samples were moist. Test pit excavated during low tide cycle, 0910 to 0930.	Photo's 1-5. Visual/manual descriptions per ASTM D2488.

WATER LEVEL**APPROXIMATE PIT DIMENSIONS AT SURFACE****SUMMARY**DATE 4 JAN 90 TIME* 0 (hours) DEPTH 2.0 (feet)LENGTH 12 FEET WIDTH 4 FEETDEPTH 10.0 ft.BOULDERS - SURFACE RIPRAP 4BAG SAMPLES 1WATER LEVEL 2.0 ft.8" TO 18" DIAMETER _____ = VOLUME _____
OVER 18" DIAMETER _____ = VOLUME _____
(number) (cu ft)

*AFTER COMPLETED



Haley & Aldrich, Inc.

TEST PIT REPORTTEST PIT NO. 89-2FILE NO. 10259-01PROJECT ROUGHANS POINTLOCATION REVERE, MASSACHUSETTSCLIENT UNITED STATES ARMY CORPS OF ENGINEERSCONTRACTOR USED J. MARCHESE & SONSEQUIPMENT USED MITSUBISHI MS 230 LC EXCAVATORLOCATION See PlanELEVATION 1.91 NGVDEXPLORATION DATE 4 JAN 90H&A REP PELNIK/RUBIK

SCALE IN FEET	STRATA CHANGE	SAMPLE NUMBER	SAMPLE DEPTH RANGE	DESCRIPTION OF MATERIALS	REMARKS
2	2.0	S1 S1A	0-2	Brown to gray, mostly coarse to fine, subrounded GRAVEL, some coarse to fine sand, little subrounded cobbles, 3 to 8-in. diameter, few subrounded boulders, 8 to 18-in. diameter, trace shell fragments, GW.	Water entering pit at 1.5-ft. depth. Pit walls stable in cohesive soils.
4	4.4	S2 S2A	4-5	Gray, mostly fine SAND, some silt, little coarse to fine, subrounded gravel, few subrounded cobbles, 3 to 8-in. diameter, trace shell fragments, SM.	
6		S3 S3A	5-7.5	Brown fibrous PEAT, trace organic silt, fine sand, pt. Organic odor.	
8		S4 S4A	7.5-9	Noted 1/2 to 2 in. layers of gray silty fine sand interbedded with peat deposit from 6.4 to 7.5 ft. depths.	
10	9.0			Gray silty clay, CL/ML. Mostly clay, some silt, no dilatancy, medium plasticity and toughness.	Photo's 6-14. Visual/Manual Descriptions per ASTM D 2488
12				Bottom of exploration at 11.0 ft. depth. All samples were moist. Test Pit excavated from 1035 to 1100 during low tide cycle.	

WATER LEVEL**APPROXIMATE PIT DIMENSIONS AT SURFACE****SUMMARY**DATE 4 JAN 90 TIME* 0 DEPTH (feet) 1.5LENGTH 18 FEET WIDTH 8 FEETDEPTH 11.0 ft.**BOULDERS**JAR SAMPLES 48" TO 18" DIAMETER 4 = VOLUME 3BAG SAMPLES 1OVER 18" DIAMETER --- = VOLUME ---
(number) (cu ft)WATER LEVEL 1.5 ft.

*AFTER COMPLETED



Haley & Aldrich, Inc.

TEST PIT REPORTTEST PIT NO. 89-3FILE NO. 10259-01PROJECT ROUGHANS POINTLOCATION REVERE, MASSACHUSETTSCLIENT UNITED STATES ARMY CORPS OF ENGINEERSCONTRACTOR USED J. MARCHESE & SONSEQUIPMENT USED MITSUBISHI MS 230 LC EXCAVATORLOCATION See PlanELEVATION 1.04 NGVDEXPLORATION DATE 4 JAN 90H&A REP PELNIK/RUBIK

SCALE IN FEET	STRATA CHANGE	SAMPLE NUMBER	SAMPLE DEPTH RANGE	DESCRIPTION OF MATERIALS	REMARKS
2	2	S1 S1A	0-2.5	Gray, mostly coarse to fine SAND, some coarse to fine, subrounded gravel, little shell fragments, SW.	Water entering test pit above organic soils on east end of pit.
4	4.2 4.5	S2 S2A	2.5-4	Brown, mostly coarse to medium SAND, some coarse to fine, subrounded gravel, little subrounded cobbles, 3 to 8-in. diameter, little shell fragments, SW.	
6		S3 S3A	5-7.5	Brown fibrous PEAT, Pt. Layer thins and disappears toward southwest. Unable to obtain sample	
8				Brown mostly coarse to fine subrounded GRAVEL, some coarse sand, little cobbles, subrounded, 3 to 8-in. diameter, little shell fragments, GW.	
10				Bottom of exploration at 7.5 ft. depth, due to collapsing sides of test pit. All samples were moist. Test Pit was excavated from 1115 to 1145 during low tide cycle.	Photos 15-22. Visual/Manual descriptions per ASTM D 2488.

WATER LEVEL

APPROXIMATE PIT DIMENSIONS AT SURFACE

SUMMARY

DATE

TIME*
(hours)DEPTH
(feet)LENGTH 22 FEET WIDTH 11 FEETDEPTH 7.5 ft.

4 JAN 90

0

4.3

BOULDERS

JAR SAMPLES 3

(tidal)

8" TO 18" DIAMETER 1 = VOLUME 1BAG SAMPLES 1OVER 18" DIAMETER --- = VOLUME ---
(number) (cu ft)WATER LEVEL 4.3 ft.

*AFTER COMPLETED



Haley & Aldrich, Inc.

TEST PIT REPORT

TEST PIT NO. 89-4

FILE NO. 10259-01

PROJECT ROUGHANS POINT

LOCATION REVERE, MASSACHUSETTS

CLIENT UNITED STATES ARMY CORPS OF ENGINEERS

CONTRACTOR USED J. MARCHESE & SONS

EQUIPMENT USED MITSUBISHI MS 230 LC EXCAVATOR

LOCATION See Plan

ELEVATION 4.30 NGVD*

EXPLORATION DATE 5 JAN 90

H&A REP PELNIK

SCALE IN FEET	STRATA CHANGE	SAMPLE NUMBER	SAMPLE DEPTH RANGE	DESCRIPTION OF MATERIALS	REMARKS
2		S1	0-2	Brown mostly coarse to fine SAND, some coarse to fine, subrounded gravel, little subrounded cobbles 3 to 8-in. diameter, trace silt, shell fragments, SW. Surficial riprap boulders, sub-angular, 18 to 36-in. diameter, previously moved for pit access. Replaced 1-6-90.	*Elevation at top of lip on seawall. Top of seawall El. 17.70, depths are from top of lip.
4	4.7			Layer turns black, organic or petroleum odor from 4 to 4.7 ft. depth.	Minor water seepage from below lip of wall.
6				Clayey organic silt, OL. Gray, mostly organic silt, some clay, trace peat fibers, occasional 1/16 to 1/2 in. layers of fine sand.	Pit walls stable in cohesive soils.
8				Increasing content of peat below 6.0-ft. depths, to peaty organic silt. Organic odor.	See attached sketches of seawall.
10				Bottom of exploration at 9.8 ft. Test pit excavated from 1000 to 1210 during low tide cycle. Backfilled pit in ±2-ft. lifts, tamped with bucket of excavator. Pushed organic soils back against piling.	USACE representative on-site to observe test pit.
					Photos 1-15 Visual/Manual descriptions per ASTM D 2488

WATER LEVEL

APPROXIMATE PIT DIMENSIONS AT SURFACE

SUMMARY

DATE	TIME* (hours)	DEPTH (feet)	LENGTH 15 FEET	WIDTH 12 FEET	DEPTH 9.8 ft.
5 JAN 90	0	---	BOULDERS - SURFICIAL RIPRAP		JAR SAMPLES ---
LOW TIDE	1120	---	8" TO 18" DIAMETER _____ = VOLUME _____		BAG SAMPLES 1
*AFTER COMPLETED			OVER 18" DIAMETER _____ = VOLUME _____ (number) (cu ft)		WATER LEVEL ---



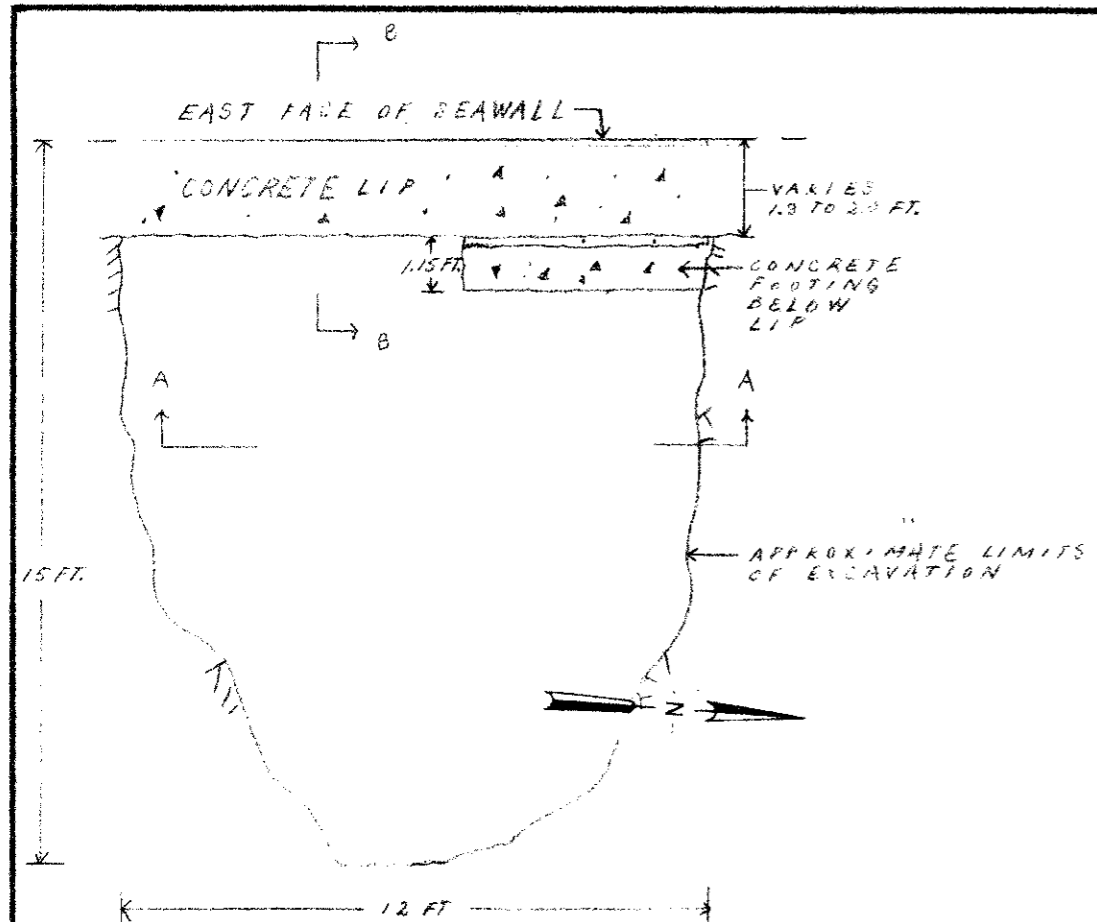
Haley & Aldrich, Inc.

TEST PIT REPORTTEST PIT NO. 89-5FILE NO. 10259-01PROJECT ROUGHANS POINTLOCATION REVERE, MASSACHUSETTSCLIENT UNITED STATES ARMY CORPS OF ENGINEERSCONTRACTOR USED J. MARCHESE & SONSEQUIPMENT USED MITSUBISHI MS 230 LC EXCAVATORLOCATION See PlanELEVATION 3.20 NGVD*EXPLORATION DATE 6 JAN 90H&A REP PELNIK

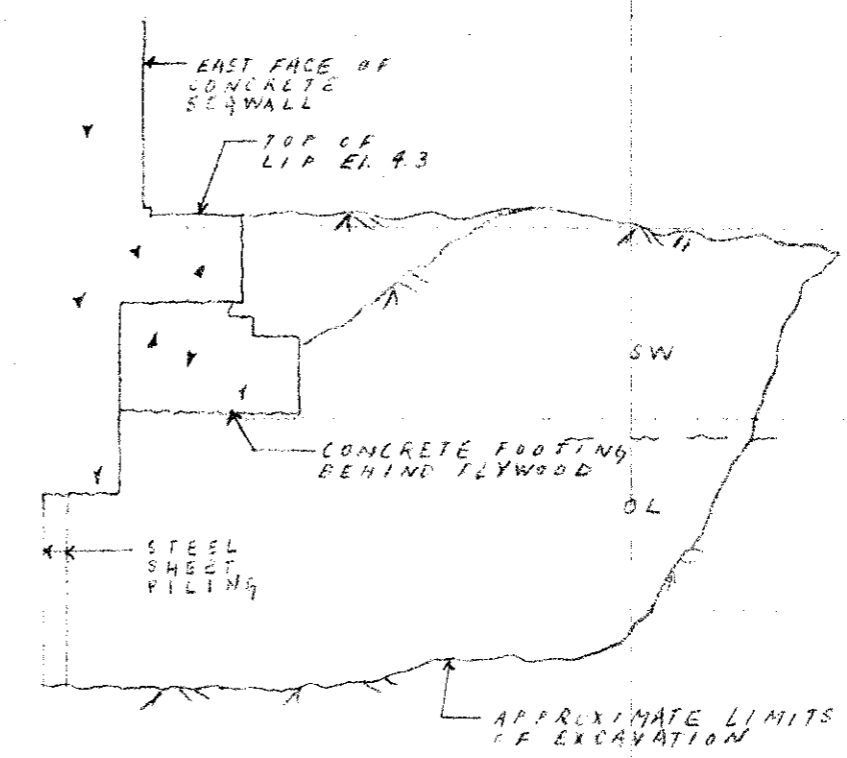
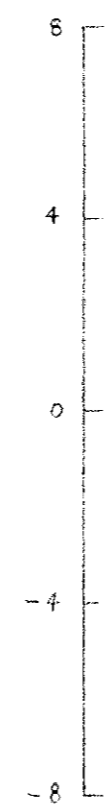
SCALE IN FEET	STRATA CHANGE	SAMPLE NUMBER	SAMPLE DEPTH RANGE	DESCRIPTION OF MATERIALS	REMARKS
2		S1	0-3	Brown mostly coarse to fine SAND, some coarse to fine, subrounded gravel, little subrounded cobbles, 3 to 8-in. diameter, trace silt, shell fragments, SW.	*Elevation at top of lip on seawall. Top of seawall El. 17.47, depths are from top of lip.
4	4			Surficial riprap, boulders, subangular 18 to 36-in. diameter, previously moved for pit access. Replaced 1-6-90 Layer turns black, with organic or petroleum odor from 3 to 4 ft.	Minor water seepage from sand layer above organic soils.
6				Brown clayey PEAT with organic silt, Pt.	Pit walls stable in organic soils.
8				Mostly fibrous PEAT, some clay, little organic silt, no dilatancy, medium plasticity and toughness. Organic odor.	See attached sketches of seawall.
10				Bottom of exploration at 9.0-ft. depth.	Photos 16-22 Visual/Manual discriptions per ASTM D 2488
				Test pit excavated during low tide cycle. Backfilled pit in ± 2 -ft. lifts, tamped with bucket of excava- tor. Pushed organic soils back against piling.	

WATER LEVEL**APPROXIMATE PIT DIMENSIONS AT SURFACE****SUMMARY**

DATE	TIME* (hours)	DEPTH (feet)	LENGTH <u>15</u> FEET	WIDTH <u>4.5</u> FEET	DEPTH <u>9.0</u> ft.
6 JAN 90	0	---	BOULDERS -SURFICIAL RIPRAP		JAR SAMPLES <u>---</u>
LOW TIDE	1230		8" TO 18" DIAMETER _____	= VOLUME _____	BAG SAMPLES <u>1</u>
			OVER 18" DIAMETER _____	= VOLUME _____	WATER LEVEL <u>---</u>
*AFTER COMPLETED			(number)	(cu ft)	



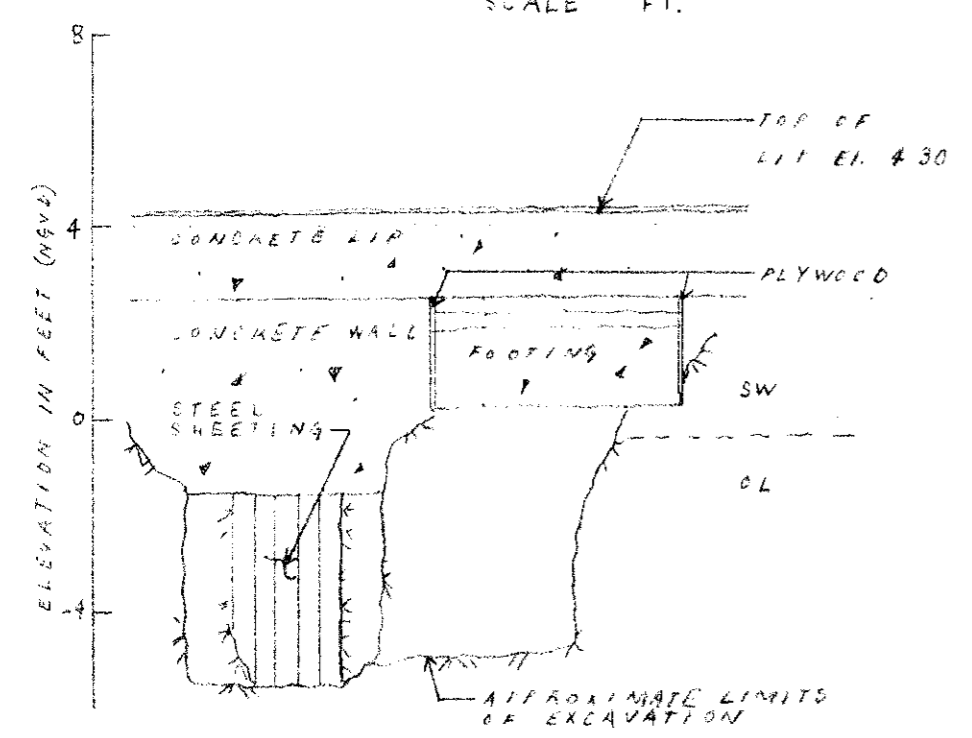
ELEVATION IN FEET (NGVD)



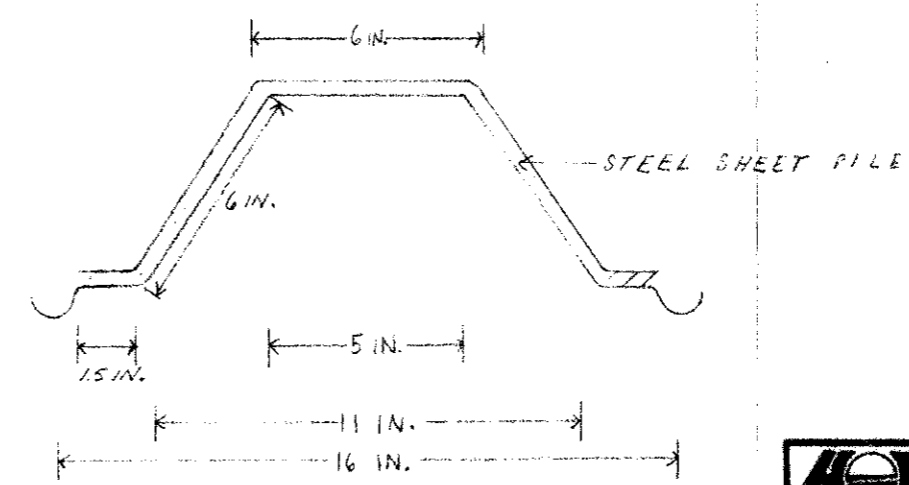
SECTION B-B

NOTES:

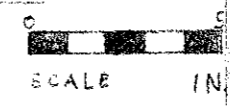
1. REFER TO TEST PIT REPORT FOR DESCRIPTION OF SURFACE SOILS.
2. DIMENSIONS AND RELATIVE ELEVATIONS SHOWN WERE MEASURED IN THE FIELD AT THIS LOCATION BY HEA PERSONNEL. ACTUAL DIMENSIONS AND ELEVATIONS AT OTHER LOCATIONS MAY VARY.



SECTION A-A



MEASUREMENTS OF EXPOSED SHEET PILES IN TEST PITS TP89-4 AND TP89-5



HA Haley & Aldrich, Inc.
Consulting Geotechnical Engineers, Geologists and Hydrogeologists

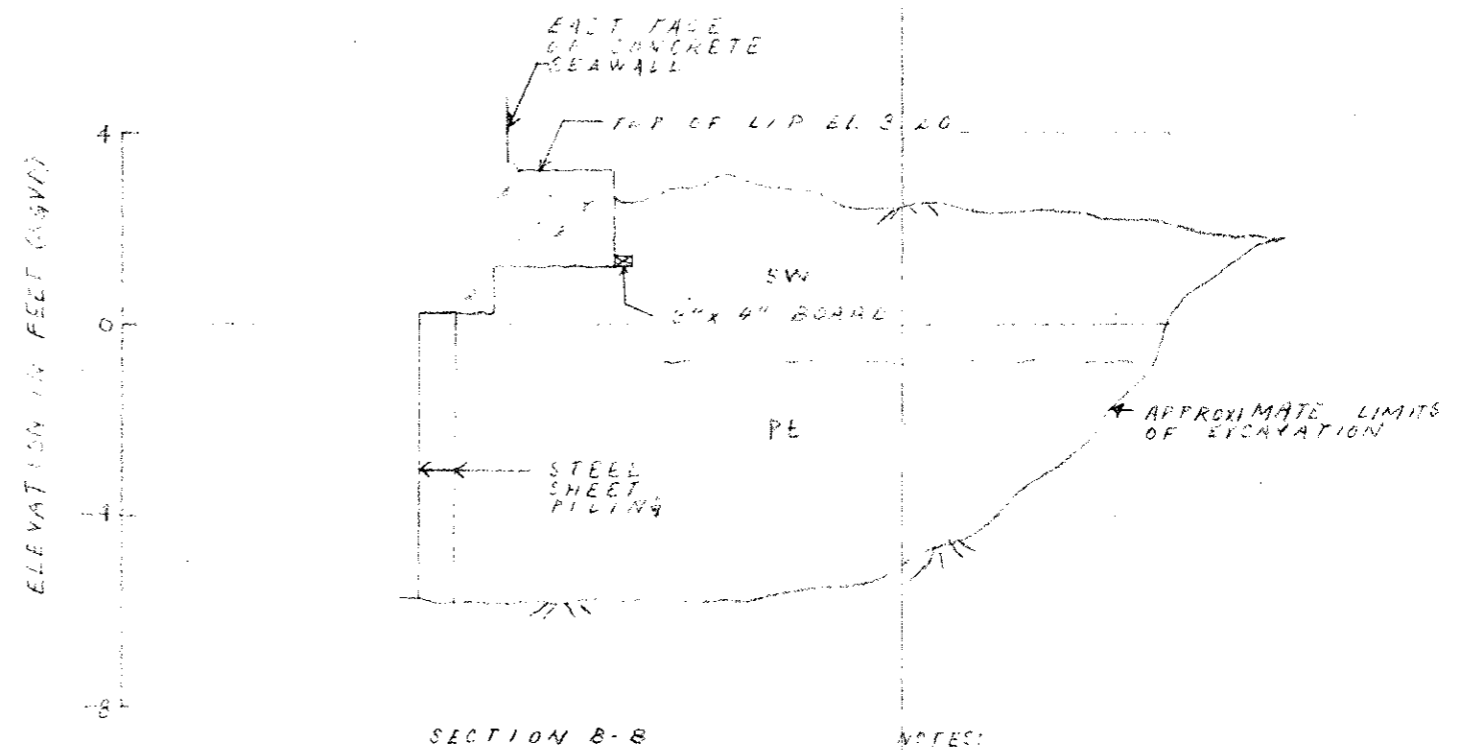
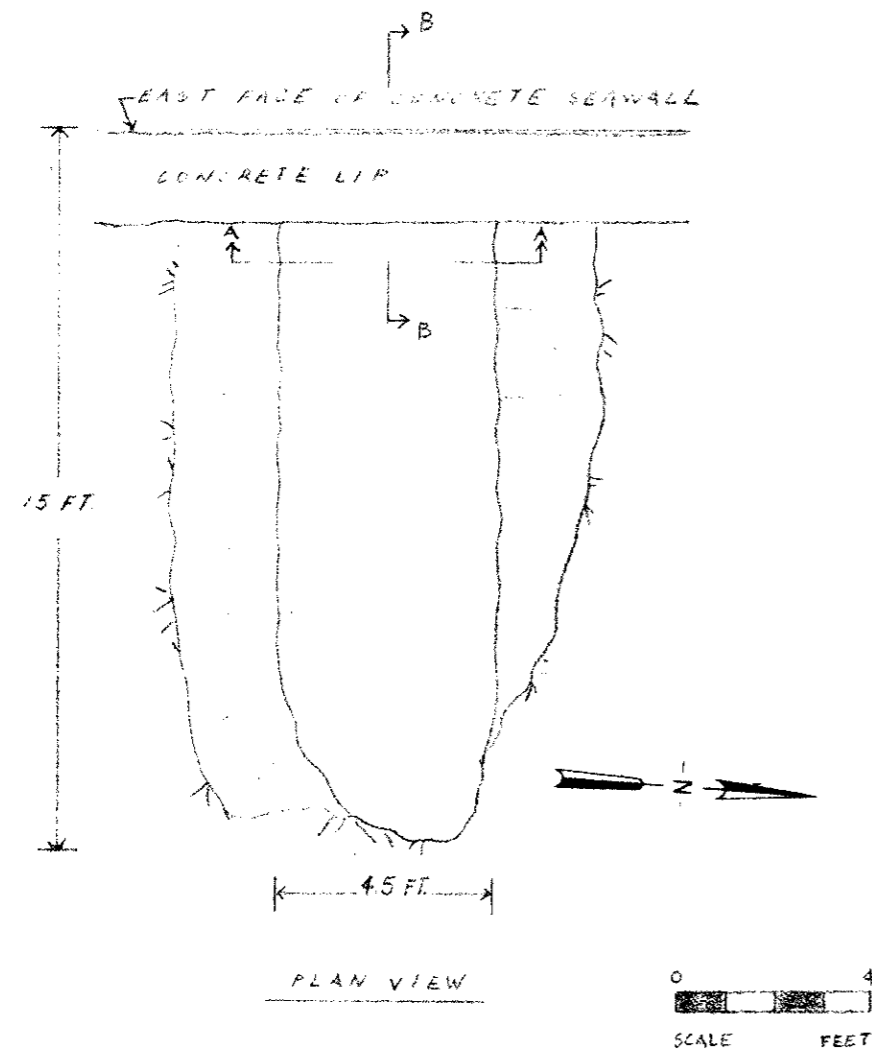
ROUGHANS POINT
REVERE, MASSACHUSETTS

TEST PIT 89-4 PLAN AND SECTIONS

SCALE: AS SHOWN

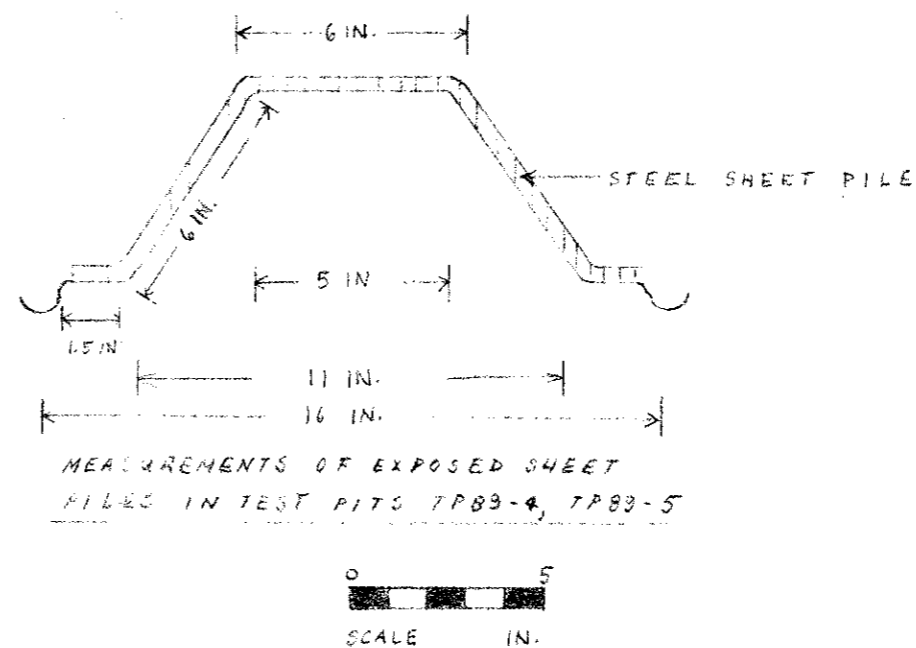
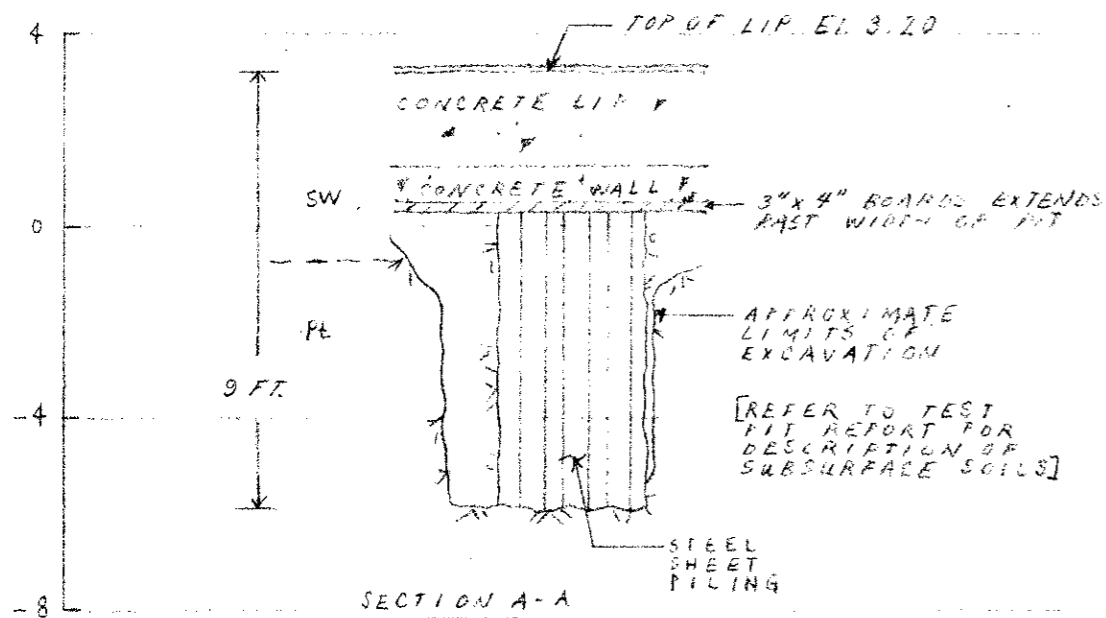
FEBRUARY 1990

FILE NO. 10259.01



NOTES:

1. REFER TO TEST PIT REPORT FOR DESCRIPTIONS OF SUBSURFACE SOILS
2. DIMENSIONS AND RELATIVE ELEVATIONS SHOWN WERE MEASURED IN THE FIELD AT THIS LOCATION BY H&A PERSONNEL. ACTUAL DIMENSIONS AND ELEVATIONS AT OTHER LOCATIONS MAY VARY.



H&A Haley & Aldrich, Inc.
Consulting Geotechnical Engineers, Geologists and Hydrogeologists

ROUGHAN'S POINT
REVERE, MASSACHUSETTS

TEST PIT 89-5 PLAN AND SECTIONS

SCALE: AS SHOWN

FEBRUARY 1990

FILE NO. 1025901

CHARRETTE

FIGURE B-2

APPENDIX C

Plotted Results of Laboratory Oedometer,
Triaxial and Gradation Tests

NOTES:

- For laboratory test programs involving tube samples, pertinent geotechnical laboratory data relating to soil descriptions and index and engineering parameters of the material, are presented in the Summary of Geotechnical Laboratory Test Results table(s) preceding these Notes. These data are plotted versus elevation (or depth) on the figure entitled "Geotechnical Laboratory Classification, Index and Engineering Parameters vs. Elevation (or Depth)." Refer to the various Appendices, identified in the Geotechnical Laboratory Test Program section of this report, for additional laboratory data in graphic form and more detailed test-specific tabulated data and test procedures such as the following:
 - grain size distribution curves;
 - compaction test moisture vs. dry density curves;
 - consolidation test log stress vs. strain curves and plots of time-rate of consolidation parameters;
 - strength test shear stress vs. strain curves and effective stress paths; and
 - tabulated data for the individual consolidation, strength and permeability tests performed.

- Soil descriptions are based on the U.S. Army Corps of Engineers and Bureau of Reclamation Unified Soil Classification System (USCS) (Bureau of Reclamation, 1986) with some modifications. Soils are described as follows: consistency or relative density, color, adjective for secondary component (when appropriate), major component (in upper case), additional components with appropriate descriptors (i.e., "some", "little" or "trace"). Each portion of the sample description is arrived at using the following guidelines:

- The scale used to qualitatively describe the consistency of cohesive soils (after Terzaghi and Peck, 1967), is based on Torvane index shear strength measurements and is as follows:

CONSISTENCY	INDEX SHEAR STRENGTH (TV, tsf)
Very soft	less than 0.13
Soft	0.13 to 0.25
Medium stiff	0.25 to 0.50
Stiff	0.50 to 1.0
Very stiff	1.0 to 2.0
Hard	greater than 2.0

Should sand or other cohesionless soils be encountered, relative density is described on the basis of Standard Penetration Test (SPT) resistance, N_6 in blows per foot (ASTM D 1586), (after Terzaghi and Peck, 1967) as follows:

RELATIVE DENSITY	SPT N_6 (blows per foot)
Very loose	0 to 4
Loose	4 to 10
Medium	10 to 30
Dense	30 to 50
Very dense	greater than 50

- Color is described using basic colors such as brown, yellow, black, red, red-brown, gray, blue-gray, etc.

- Component definitions by gradations are as follows:

MATERIAL	DEFINITIONS	FRACTIONS	U.S. STANDARD SIEVE PASSING	RETN. ON
Cobbles	Material passing through an 8-in. square opening and retained on a 3-in. sieve.			3-in.
Gravel	Material passing the 3-in. sieve and retained upon the No.4 sieve.	Coarse Fine	3-in. 3/4-in.	3/4-in. No.4
Sand	Material passing the No.4 sieve and retained upon the No.200 sieve.	Coarse Medium Fine	No.4 No.10 No.40	No.10 No.40 No.200
Silt	Material passing the No.200 sieve, classified on the basis of its Atterberg Limits; on the Plasticity Chart, silts plot below the A-Line. Typically, silts exhibit relatively low to no plasticity, low dry strengths, and quick response to dilatancy checks.		No.200	
Clay	Material passing the No.200 sieve, classified on the basis of its Atterberg Limits; on the Plasticity Chart, clays plot above the A-Line. Typically, clays exhibit some to significant plasticity, medium to high dry strength and slow to no response to dilatancy checks.		No.200	
Organic Soils	Organic Silt and Organic Clay are identified on the basis of their Atterberg Limits and the effect of oven-drying on the liquid limit. Visual aspects such as dark brown, gray or black color, a medium to pungent odor and soft consistency are indicators of organic nature. Organic clay plots above the A-Line and organic silt plots below this line on the Plasticity Chart.		No.200	
Highly Organic Soils	Highly organic soils such as Peat are identified by a combination of the following: visual aspects such as dark brown, dark gray or black color and/or the appearance of roots or fibers; medium to pungent odor, such as hydrogen sulfide, attributable to decaying organic matter; Atterberg Limits; and organic matter content.			

- MAJOR COMPONENT:
Material is classified as coarse-grained (SAND or GRAVEL) or fine-grained (CLAY or SILT) on the basis of the percentage of material finer than the U.S. Standard No.200 sieve, in accordance with USCS.

If more than half the sample (by weight) is coarser than the No.200 sieve (0.075mm), then the major component is coarse-grained (either SAND or GRAVEL, whichever is present in the largest percentage, by weight). This coarse-grained component is further described by the predominant fractions (coarse, medium and/or fine) which are present.

If more than half the sample is finer than the No.200 sieve, then the major component is fine-grained (either CLAY or SILT, depending upon the Atterberg Limits of the sample and their location with respect to the A-Line on the plasticity chart.)

- ADJECTIVE:
The major component is preceded by the secondary component in the form of a descriptor, such as sandy, clayey or gravelly, if this secondary component is present in excess of 20 percent by weight.
 - ADDITIONAL COMPONENTS:
Other components of the soil are included in the sample description preceded by the following descriptors on the basis of the percentages at which they occur:
- | DESCRIPTOR | PERCENTAGE (by wt.) |
|------------|---------------------|
| Some | greater than 20 |
| Little | 11 to 20 |
| Trace | 5 to 10 |

- Terminology related to stratified or heterogeneous soils is applied as follows:

STRATIFICATION	THICKNESS OF STRATA
Lamina	0 to 1/16 in. (cohesive soil)
Parting	0 to 1/16 in. (cohesionless soil)
Seam	1/16 to 1/2 in.
Layer	1/2 to 12 in.
Stratum	Usually greater than 12 in.

OTHER IRREGULARITIES	DEFINITION
Pocket	Small erratic deposit usually less than 1/2-in. thick, not laterally extensive. Identified in conjunction with other test boring data.

Lens	Lenticular deposit, larger than pocket, also not laterally extensive. Identified in conjunction with other test boring data.
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FREQUENCY	DEFINITION
Occasional	One or less stratification per foot of thickness.

Frequent	More than one stratification per foot of thickness.
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Very frequent	More than one stratification per inch of thickness.
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Interbedded	Applied to strata of soil lying between or alternately with other strata of a different nature.
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- Unless otherwise noted in the Boring No. and Sample No. column of the Summary of Geotechnical Laboratory Test Results table, the laboratory test specimens are obtained from 3.0-in. outside-diameter thin-walled tube samples. Refer to the Field Exploration section of the report for the specific sampling method employed (usually in accordance with ASTM D 1587). Prior to extrusion, the tube samples are stored in a room maintained at between 90 and 100 percent relative humidity. Specimens are extruded from short sections of the tube sample to help minimize the shear disturbance due to extrusion. Consolidation, strength and permeability test specimens are trimmed in the humid room.

- Grain size distributions are measured in general conformance with ASTM D 421 and D 422. Suggestions from Lambe (1951) are incorporated in the techniques for sample handling. The distribution of grain sizes retained upon the No.200 sieve is evaluated using various sieves including those listed above, while the distribution of fine-grained material is evaluated using the hydrometer method. It is important to remember that sampling soils according to the split-spoon method (ASTM D 1586) using the split-barrel with a 2.0-in. outside diameter, only allows for sampling of soil particles which can pass through a cylindrical opening which is 1.375 in. in diameter. Thus, cobble and coarse gravel components of the soil are selectively removed from the sample prior to testing.

- Natural water contents, w_n , are measured in accordance with ASTM D 2216, except that soils containing organic materials are oven-dried at 65C. Typically, "natural" water contents are actually the water contents of the material "as-received" at the laboratory.

- Atterberg Limits are performed in conformance with ASTM D 4318. Clays and organic materials are never air-dried prior to evaluating the limits due to the potential for nonunique rehydration. Liquid limits are determined using the multipoint method on soil beginning at about the natural water content using a flat grooving tool and a cup device with a hard-rubber base.

- Loss on Ignition is determined by measuring the loss in weight of a 5 to 10g-sample of oven-dried (7=65C) No.40 material caused by heating the material in a small porcelain crucible with a propane torch until the color of the soil is homogeneous or until no additional weight is lost. Weights are measured to the nearest 0.0001g.

- Total unit weights, γ , measured in accordance with ASTM D 2397 and presented in parentheses, e.g., (120.2), indicate an average for the entire thin-walled tube sample (the first value listed for a given tube sample) and for the individual short tube sections for the values listed at increasing depths. Other unit weights are obtained from individual consolidation, strength and permeability test samples, where available, and are based on the weights and volumes of those samples.

- Compaction characteristics are determined in general accordance with either ASTM D 1557 or D 698; the specific procedure used is indicated on the individual compaction curves. Typically, ASTM D 1557 Method C is employed, regardless of the percentage of coarse gravel in the sample. Corrections for the +3/4-in. fraction are made in the field as part of the Sand Cone Density Test (ASTM D 1556).

- The index strength tests, Torvane, IV; Pocket Penetrometer, PP; and Shear Vane, SV, are performed in the sample tube during the sample extrusion process. When the soil to be tested has been pushed with a hydraulic jack such that it is flush with the cutting template surface, the index strength tests are performed in the order listed above. All strengths are reported in tons per square foot (tsf). The test values reported for IV and PP tests typically represent the average of three measurements made with each device on each exposed surface. The PP value is divided by two since the value obtained from the instrument is interpreted as a measure of the compressive strength of the material. The SV test is performed only once on each surface. After measurement of the "undisturbed" shear strength with the SV, the vane is rotated 360 degrees in the soil sample. This rotation is immediately followed by measurement of the "remolded", R, strength.

- Consolidation Tests are one-dimensional, incrementally-loaded Oedometer Tests, performed in general conformance with ASTM D 2435. Typically, the load increment ratio, LIR , ($=\Delta\sigma_v'/\sigma_v'$) is approximately equal to 0.7 for stresses greater than 0.8 tsf, except on reloading cycles, where LIR is equal to one.

Preconsolidation pressure, σ'_{p_0} , is determined via the Casagrande construction on the strain vs. log vertical stress curves from these tests, considering vertical strain at the end of primary consolidation. Time to primary, called t_p or End of Primary, EOP, is estimated using the Casagrande construction on displacement vs. log elapsed time, plotted for each increment. End of Increment, EOI, strains are plotted on the log stress vs. strain curve for load increments immediately followed by unload increments.

The recompression ratio, RR , is determined from an unload-reload cycle performed after at least two to three percent strain has been incurred by the sample. Unloading is carried out to an overconsolidation ratio, OCR, equal to 8. The compression ratio, CR , is evaluated as the slope of the steepest portion of the log vertical stress vs. strain curve during virgin compression.

Test quality is based on engineering judgement following review of the log stress curve vs. strain curve and other consolidation data such as coefficient of consolidation and coefficient of secondary compression vs. the log of the stress ratio, ($=\sigma'_v/\sigma'_{p_0}$). The qualitative scale is as follows: "E" (excellent), "VG" (very good), "G" (good), "F" (fair), "P" (poor).

- The shear strength of fine-grained soils is typically evaluated on the basis of triaxial tests. The types of tests performed, in order of increasing degree of sophistication, are as follows:

UU	Unconsolidated Undrained Triaxial Compression
CIUC	Isotropically Consolidated Undrained Triaxial Compression
CK ₀ UC	Anisotropically Consolidated Undrained Triaxial Compression

The UU triaxial test is performed in general conformance with ASTM D 2850. Several modifications, including the measurement of pore pressure and other variations described below, are incorporated in the test procedure to enable better interpretation of the test results. The samples are tested at the "as-sampled" (or "as-received") water content and hence, the reliability of the measured pore pressures is related to the initial "as-sampled" degree of saturation. The samples are allowed to equilibrate for several hours at the desired test cell pressure so that an estimate of the initial effective stress can be obtained. θ values ($=\Delta u/\Delta \sigma'_v$) are checked prior to shear.

Since pore pressure, u , is measured at the base of the sample, the strain rate at which the sample is sheared should be slow enough to allow for some equilibration of u throughout the sample. Typically, silty CLAY and SILT samples are sheared at an axial strain rate equal to approximately 4 percent per hour, which is about ten times faster than is typical for a consolidated undrained triaxial test. Thus, the tests can be performed in a reasonable amount of time and there is some increase in strain rate to counteract the effects of disturbance, while there is some time allowed for u equilibration.

Shear stress, q , is calculated taking into account the resistance of the membrane and the changing area of the sample. The axial strain at failure, ϵ_f or ϵ_p , is that at peak shear stress, q_u , which is usually considered the undrained shear strength of the soil.

The CIUC triaxial test is performed in general accordance with the sample handling and preparation techniques suggested by ASTM D 2850. The procedures followed for performance of the backpressure, consolidation and shearing portions of the test are obtained from Bishop and Henkel (1957). Details regarding backpressure levels, consolidation history and shear data, including stress vs. strain curves, effective stress paths, pore pressure parameters and Young's modulus, are contained in the Appendix identified in the geotechnical laboratory test program section of this report.

- Constant Head Permeability tests are performed in general conformance with the U.S. Army Corps of Engineers procedure designated EM 1110-2-1906 (dated 30 November 1970). All "undisturbed" samples and laboratory-prepared samples which are estimated to have permeabilities less than approximately 1×10^{-4} cm/sec are tested using flexible wall equipment.

LEGEND:

ASTM	American Society of Testing Materials.
q_u, q_p	Liquid Limit, Plastic Limit and Plasticity Index, respectively.
w_n	Natural water content.
LOI	Loss on Ignition, typically used as a relative measure of the organic content of the material.
γ_t, γ_d	Total Unit Weight and Dry Unit Weight, respectively.
γ_{max}, w_{opt}	Compaction characteristics: Max. Dry Unit Weight and Optimum Water Content, respectively.
IV, PP	Torvane and Pocket Penetrometer tests, respectively, using hand-held devices marketed by Soiltest, Inc.
SV, R	Shear Vane test using the hand-held Lab Vane device marketed by Geonor. (R) refers to the vane test result on remolded soil.
OED	Oedometer test.
σ'_v, σ'_{p_0}	Effective Vertical Stress and Preconsolidation Pressure, respectively.
OCR	Overconsolidation Ratio, ($=\sigma'_v/\sigma'_{p_0}$).
CR, RR	Compression and Recompression Ratios ($=\Delta \epsilon / \Delta \log \sigma'_v$) during virgin compression and recompression, respectively.
C_v	Coefficient of Consolidation, evaluated on the basis of displacement vs. log elapsed time ($=0.197H^2/t_{50}$).
C_α	Coefficient of Secondary Compression ($=\Delta \epsilon / \Delta \log t$), evaluated sometime after time to primary has been achieved.
UU	Unconsolidated Undrained Triaxial Compression test with pore pressure measurements.
CIUC	Isotropically Consolidated Undrained Triaxial Compression test.
CK ₀ UC	Anisotropically (K_0) Consolidated Undrained Triaxial Compression Test.
DSS	Direct Simple Shear Test.
q	Shear Stress ($=(\sigma'_1 - \sigma'_3)/2$)
p'	Average Effective Stress ($=(\sigma'_1 + \sigma'_3)/2$)
q_u, q_p	Undrained Shear Strength, typically peak value.
ϵ_p, ϵ_f	Axial Strain at peak shear stress and/or failure.
k	Coefficient of Permeability.

REFERENCES:

- American Society of Testing Materials, (1987) 1987 Annual Book of ASTM Standards, Volume 04.08, Soil and Rock; Building Stones, Philadelphia, 1189p.
- Bureau of Reclamation, (1986), Amster K. Howard, Geotechnical Branch Training Manual No.4, 2nd. edition, "Laboratory Classification of Soils, Unified Soil Classification System," Bureau of Reclamation, Engineering and Research Center, Denver, 102p.
- Bishop, A.W. and D.J. Henkel, (1957) The Measurement of Soil Properties in the Triaxial Test, Edward Arnold Ltd., London, 190p.
- Lambe, T.W., (1951) Soil Testing, John Wiley & Sons, Inc., 165p.
- Terzaghi, K. and R.B. Peck, (1967) Soil Mechanics in Engineering Practice, 2nd. edition, John Wiley & Sons, New York (1st. ed. 1948).
- U.S. Army Corps of Engineers, (1970) Engineering and Design, "Laboratory Soils Testing", Engineer Manual EM 1110-2-1906, 30 November 1970.

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ROUGHANS POINT
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SOIL TEST PROGRAM NOTES

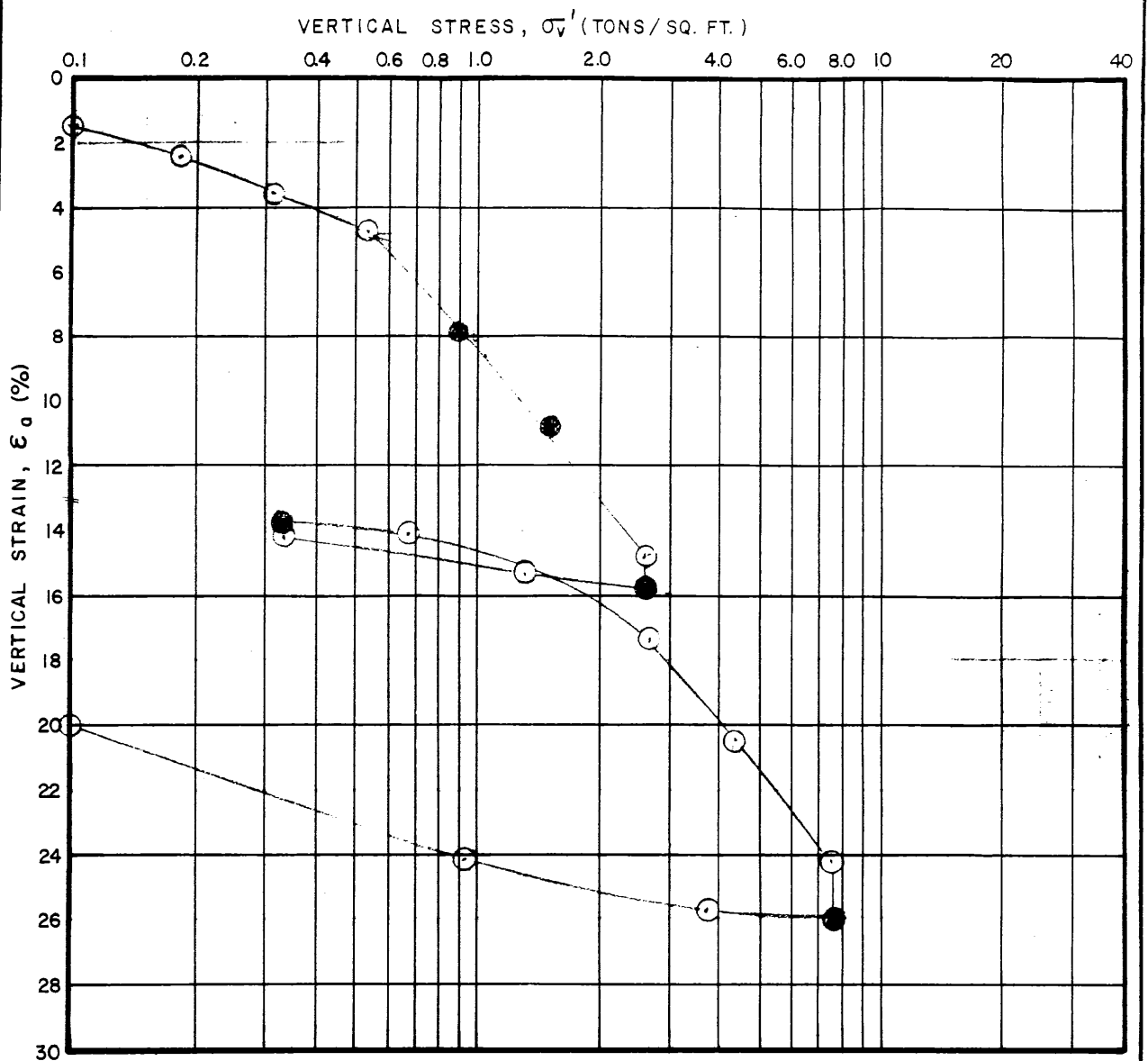
FEBRUARY 1990

FIGURE C1

HALEY & ALDRICH, INC.		CONSOLIDATION TEST SUMMARY																																																																																																																																																																																																									
PROJECT: Roughans Point Revere, Massachusetts		FILE No. 10259-01 DATE: 12-26-89 TEST No. OED1 CALC. BY: FJP/RCC CHCKD.BY: GY																																																																																																																																																																																																									
EXPL. No.: 889-3	SAMPLE DESCRIPTION: Soft dark gray ORGANIC CLAY																																																																																																																																																																																																										
SAMPLE No.: U-1																																																																																																																																																																																																											
DEPTH (ft.): 22.5	ATTERBERG LIMITS (%): WL = 62.0 IP = 34.2 WP = 27.8 IL = 0.8																																																																																																																																																																																																										
INITIAL FINAL Test Quality : () Excellent () Very Good () Good (X) Fair () Poor		STRESS STRAIN PARAMETERS:																																																																																																																																																																																																									
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SAMPLE HT. (cm) 1.898 1.587		RR = 0.030																																																																																																																																																																																																									
SAMPLE DIAMETER (cm) 6.345																																																																																																																																																																																																											
SAMPLE AREA (sq.cm) 31.619																																																																																																																																																																																																											
WET SAMPLE WT. (g) 98.870	NOTES: 1. CR and RR calculated as the change in strain divided by the change in log stress	Overburden Stress, sig'vo= _____ tsf																																																																																																																																																																																																									
DRY SAMPLE WT. (g) 63.710	2. Specific gravity estimated assuming final degree of saturation S = 100%	Vertical Strain at sig'vo= _____ %																																																																																																																																																																																																									
TOT. UNIT WT. (pcf) 102.8																																																																																																																																																																																																											
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<table border="1"> <thead> <tr> <th>INC. No.</th> <th>VERT. STRESS (tsf)</th> <th>VERTICAL STRAIN (%) (EOP)</th> <th>VERTICAL STRAIN (%) (EOI)</th> <th>VOID RATIO, e (EOP)</th> <th>STRESS RATIO (sig'vc/ sig'p)</th> <th>COEFF. CONS., cv (sqcm/sec)</th> <th>COEFF. SEC. COMPR. (%)</th> <th>LOG STRESS RATIO log (sig'vc/ sig'p)</th> <th>REMARKS</th> </tr> </thead> <tbody> <tr><td>1</td><td>0.06</td><td>1.12</td><td>1.17</td><td>1.563</td><td>0.067</td><td>1.64E-03</td><td>0.1000</td><td>-1.1760</td><td></td></tr> <tr><td>2</td><td>0.10</td><td>1.48</td><td>1.58</td><td>1.554</td><td>0.111</td><td>2.88E-03</td><td>0.1067</td><td>-0.9542</td><td></td></tr> <tr><td>3</td><td>0.18</td><td>2.34</td><td>2.57</td><td>1.532</td><td>0.200</td><td>1.60E-03</td><td>0.1100</td><td>-0.6989</td><td></td></tr> <tr><td>4</td><td>0.31</td><td>3.41</td><td>3.83</td><td>1.504</td><td>0.344</td><td>1.56E-03</td><td>0.4216</td><td>-0.4628</td><td></td></tr> <tr><td>5</td><td>0.53</td><td>4.75</td><td>4.97</td><td>1.469</td><td>0.589</td><td>1.52E-03</td><td>0.3000</td><td>-0.2299</td><td></td></tr> <tr><td>6</td><td>0.90</td><td></td><td>7.97</td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>7</td><td>1.53</td><td></td><td>10.85</td><td></td><td></td><td></td><td></td><td></td><td></td></tr> <tr><td>8</td><td>2.60</td><td>14.70</td><td>15.75</td><td>1.211</td><td>2.889</td><td>7.11E-04</td><td>1.1765</td><td>0.46073</td><td></td></tr> <tr><td>9</td><td>1.30</td><td>15.34</td><td>15.35</td><td>1.195</td><td>1.444</td><td>2.37E-03</td><td>0.0040</td><td>0.15970</td><td></td></tr> <tr><td>10</td><td>0.33</td><td>14.16</td><td>13.80</td><td>1.225</td><td>0.367</td><td>6.79E-04</td><td>0.2143</td><td>-0.4357</td><td></td></tr> <tr><td>11</td><td>0.66</td><td>14.10</td><td>14.12</td><td>1.227</td><td>0.733</td><td>2.46E-03</td><td>0.0455</td><td>-0.1346</td><td></td></tr> <tr><td>12</td><td>1.30</td><td>15.34</td><td>15.65</td><td>1.195</td><td>1.444</td><td>2.15E-03</td><td>0.1238</td><td>0.15970</td><td></td></tr> <tr><td>13</td><td>2.60</td><td>17.28</td><td>17.42</td><td>1.144</td><td>2.889</td><td>2.91E-03</td><td>0.0161</td><td>0.46073</td><td></td></tr> <tr><td>14</td><td>4.42</td><td>20.50</td><td>21.70</td><td>1.061</td><td>4.911</td><td>4.35E-04</td><td>1.0000</td><td>0.69117</td><td></td></tr> <tr><td>15</td><td>7.51</td><td>24.00</td><td>26.05</td><td>0.970</td><td>8.344</td><td>9.90E-04</td><td>0.9137</td><td>0.92139</td><td></td></tr> <tr><td>16</td><td>3.76</td><td>25.88</td><td>25.81</td><td>0.921</td><td>4.172</td><td>5.12E-03</td><td>0.0313</td><td>0.62036</td><td></td></tr> <tr><td>17</td><td>0.94</td><td>24.13</td><td>23.56</td><td>0.967</td><td>1.043</td><td>8.34E-04</td><td>0.1786</td><td>0.01842</td><td></td></tr> <tr><td>18</td><td>0.10</td><td>19.95</td><td>19.20</td><td>1.075</td><td>0.111</td><td>5.72E-04</td><td>1.1905</td><td>-0.9542</td><td></td></tr> <tr><td>19</td><td>seating</td><td></td><td>16.40</td><td></td><td></td><td></td><td></td><td></td><td></td></tr> </tbody> </table>				INC. No.	VERT. STRESS (tsf)	VERTICAL STRAIN (%) (EOP)	VERTICAL STRAIN (%) (EOI)	VOID RATIO, e (EOP)	STRESS RATIO (sig'vc/ sig'p)	COEFF. CONS., cv (sqcm/sec)	COEFF. SEC. COMPR. (%)	LOG STRESS RATIO log (sig'vc/ sig'p)	REMARKS	1	0.06	1.12	1.17	1.563	0.067	1.64E-03	0.1000	-1.1760		2	0.10	1.48	1.58	1.554	0.111	2.88E-03	0.1067	-0.9542		3	0.18	2.34	2.57	1.532	0.200	1.60E-03	0.1100	-0.6989		4	0.31	3.41	3.83	1.504	0.344	1.56E-03	0.4216	-0.4628		5	0.53	4.75	4.97	1.469	0.589	1.52E-03	0.3000	-0.2299		6	0.90		7.97							7	1.53		10.85							8	2.60	14.70	15.75	1.211	2.889	7.11E-04	1.1765	0.46073		9	1.30	15.34	15.35	1.195	1.444	2.37E-03	0.0040	0.15970		10	0.33	14.16	13.80	1.225	0.367	6.79E-04	0.2143	-0.4357		11	0.66	14.10	14.12	1.227	0.733	2.46E-03	0.0455	-0.1346		12	1.30	15.34	15.65	1.195	1.444	2.15E-03	0.1238	0.15970		13	2.60	17.28	17.42	1.144	2.889	2.91E-03	0.0161	0.46073		14	4.42	20.50	21.70	1.061	4.911	4.35E-04	1.0000	0.69117		15	7.51	24.00	26.05	0.970	8.344	9.90E-04	0.9137	0.92139		16	3.76	25.88	25.81	0.921	4.172	5.12E-03	0.0313	0.62036		17	0.94	24.13	23.56	0.967	1.043	8.34E-04	0.1786	0.01842		18	0.10	19.95	19.20	1.075	0.111	5.72E-04	1.1905	-0.9542		19	seating		16.40						
INC. No.	VERT. STRESS (tsf)	VERTICAL STRAIN (%) (EOP)	VERTICAL STRAIN (%) (EOI)	VOID RATIO, e (EOP)	STRESS RATIO (sig'vc/ sig'p)	COEFF. CONS., cv (sqcm/sec)	COEFF. SEC. COMPR. (%)	LOG STRESS RATIO log (sig'vc/ sig'p)	REMARKS																																																																																																																																																																																																		
1	0.06	1.12	1.17	1.563	0.067	1.64E-03	0.1000	-1.1760																																																																																																																																																																																																			
2	0.10	1.48	1.58	1.554	0.111	2.88E-03	0.1067	-0.9542																																																																																																																																																																																																			
3	0.18	2.34	2.57	1.532	0.200	1.60E-03	0.1100	-0.6989																																																																																																																																																																																																			
4	0.31	3.41	3.83	1.504	0.344	1.56E-03	0.4216	-0.4628																																																																																																																																																																																																			
5	0.53	4.75	4.97	1.469	0.589	1.52E-03	0.3000	-0.2299																																																																																																																																																																																																			
6	0.90		7.97																																																																																																																																																																																																								
7	1.53		10.85																																																																																																																																																																																																								
8	2.60	14.70	15.75	1.211	2.889	7.11E-04	1.1765	0.46073																																																																																																																																																																																																			
9	1.30	15.34	15.35	1.195	1.444	2.37E-03	0.0040	0.15970																																																																																																																																																																																																			
10	0.33	14.16	13.80	1.225	0.367	6.79E-04	0.2143	-0.4357																																																																																																																																																																																																			
11	0.66	14.10	14.12	1.227	0.733	2.46E-03	0.0455	-0.1346																																																																																																																																																																																																			
12	1.30	15.34	15.65	1.195	1.444	2.15E-03	0.1238	0.15970																																																																																																																																																																																																			
13	2.60	17.28	17.42	1.144	2.889	2.91E-03	0.0161	0.46073																																																																																																																																																																																																			
14	4.42	20.50	21.70	1.061	4.911	4.35E-04	1.0000	0.69117																																																																																																																																																																																																			
15	7.51	24.00	26.05	0.970	8.344	9.90E-04	0.9137	0.92139																																																																																																																																																																																																			
16	3.76	25.88	25.81	0.921	4.172	5.12E-03	0.0313	0.62036																																																																																																																																																																																																			
17	0.94	24.13	23.56	0.967	1.043	8.34E-04	0.1786	0.01842																																																																																																																																																																																																			
18	0.10	19.95	19.20	1.075	0.111	5.72E-04	1.1905	-0.9542																																																																																																																																																																																																			
19	seating		16.40																																																																																																																																																																																																								

(Data stored on diskette No. GLD35a).

(Skeleton spreadsheet last revised: 9 Jan. 1990, gy)



SAMPLE DESCRIPTION Medium dark gray ORGANIC CLAY,
little fine sand, with shell fragments

BORING NO. B89-3

SAMPLE NO. U1

ATTERBERG LIMITS (%) W_N 55.2
 W_L 62.0
 W_P 27.8
 I_P 34.2

DEPTH (FEET) 22.5

ELEVATION -9.11

DATUM NGVD

	WATER CONTENT (%)	VOID RATIO, e
INITIAL	55.2	1.592
FINAL	42.4	1.167

PRECONSOLIDATION PRESSURE, σ_p' (TSF) 0.9

COMPRESSION RATIO, CR 0.202

RECOMPRESSION RATIO, RR 0.030



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ROUGHANS POINT
 REVERE, MASSACHUSETTS

CONSOLIDATION TEST NO. OED1

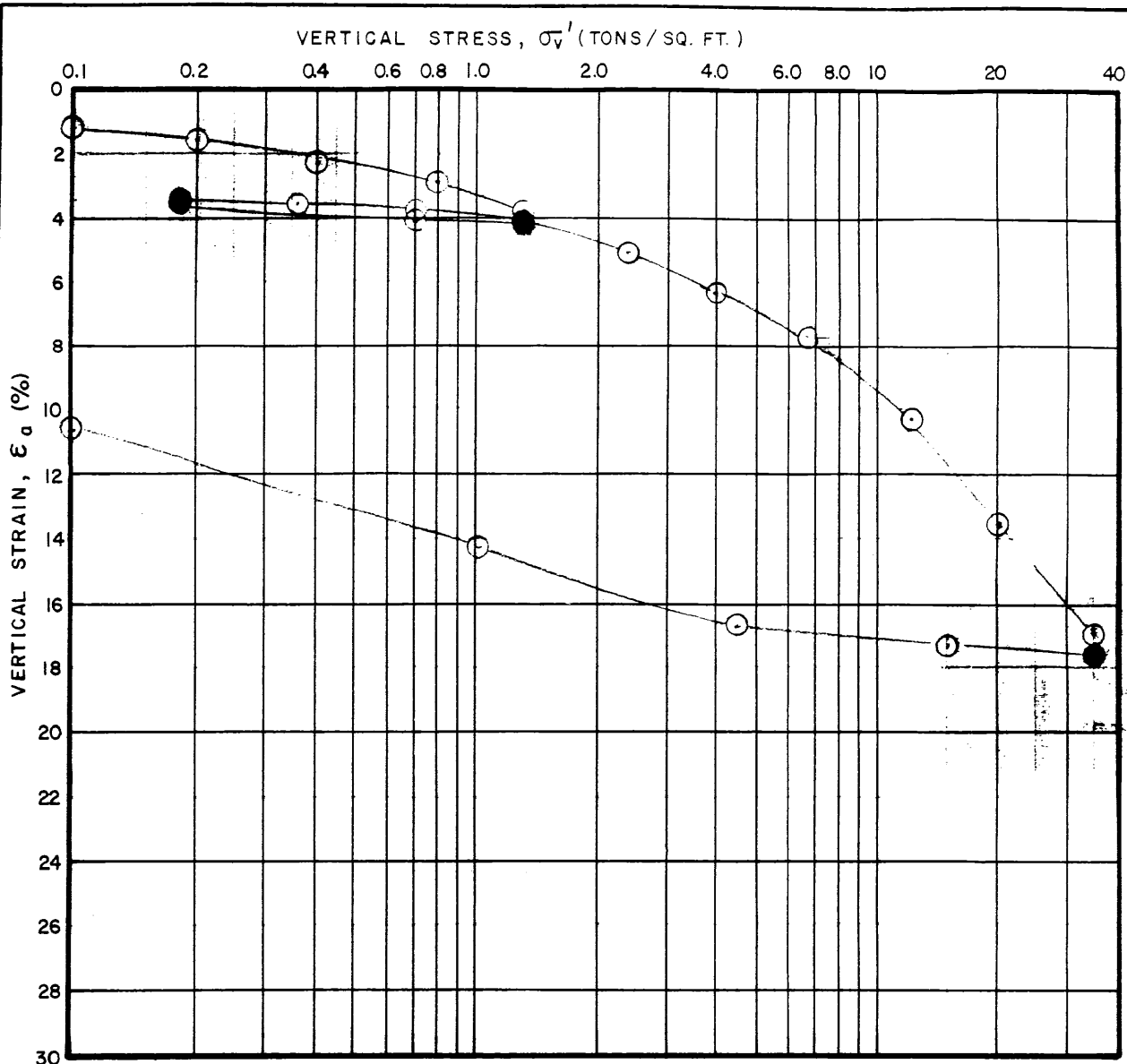
FILE NO. 10259-01

HALEY & ALDRICH, INC.				CONSOLIDATION TEST SUMMARY				FILE No. 10259-01	
PROJECT: Roughans Point Revere, Massachusetts								DATE: 12-29-89	
								TEST No. OED2	
								CALC. BY: FJF/RCC	
								CHCKD.BY: GY	
EXPL. No.: B89-3		SAMPLE DESCRIPTION: Gray green silty CLAY with some							
SAMPLE No.: U-4		medium to fine sand							
DEPTH (ft.): 43.3		ATTERBERG LIMITS (%):		WL = 33.6 IP = 16.8					
				WP = 16.8 IL = 0.7					
				STRESS STRAIN PARAMETERS:					
INITIAL		FINAL		Test Quality :		() Excellent			
WATER CONTENT (%)		28.45 27.10		() Very Good				Preconsolidation	
DEG. OF SAT. (%)		105.0 127.9		() Good				Pressure, sig'p 8.7 tsf	
SAMPLE HT. (cm)		1.905 1.730		(X) Fair				CR = 0.144	
SAMPLE DIAMETER (cm)		6.344		() Poor				RR = 0.006	
SAMPLE AREA (sq.cm)		31.609							
WET SAMPLE WT. (g)		120.100		NOTES: 1. CR and RR calculated as the change in				Overburden	
DRY SAMPLE WT. (g)		93.500		strain divided by the change in log stress				Stress, sig'vo= _____ tsf	
TOT. UNIT WT. (pcf)		124.5		2. Specific gravity estimated assuming				Vertical Strain	
EST. SPECIFIC GRAVITY		2.681		final degree of saturation S = 100%				at sig'vo= _____ %	
VOID RATIO, e		0.726 0.568							
SOLIDS HT. (cm)		1.104							

INC. No.	VERT. STRESS (tsf)	VERTICAL STRAIN (%) (EOP)	VERTICAL STRAIN (%) (EOI)	VOID RATIO, e (EOP)	STRESS RATIO (sig'vc/ sig'p)	COEFF. CONS., cv (sqcm/sec)	COEFF. SEC. COMPR. (%)	LOG STRESS RATIO log (sig'vc/ sig'p)	REMARKS
1	0.06	1.31	1.30	0.704	0.007	5.87E-03	0.0042	-2.1613	
2	0.10	1.44	1.47	0.702	0.011	9.16E-03	0.0192	-1.9395	
3	0.20	1.89	1.92	0.694	0.023	2.88E-03	0.0111	-1.6384	
4	0.40	2.27	2.43	0.687	0.046	1.61E-02	0.0543	-1.3374	
5	0.80	3.15	3.35	0.672	0.092	7.93E-03	0.0588	-1.0364	
6	1.40	3.85	4.18	0.660	0.161	8.75E-03	0.0625	-0.7933	
7	0.70	4.07	4.03	0.656	0.080	1.09E-02	0.0200	-1.0944	
8	0.18	3.49	3.41	0.666	0.021	3.90E-03	0.0700	-1.6842	
9	0.36	3.53	3.53	0.665	0.041	6.97E-03	0.0000	-1.3832	
10	0.70	3.78	3.82	0.661	0.080	8.74E-03	0.0240	-1.0944	
11	1.40	4.25	4.36	0.653	0.161	8.67E-03	0.0036	-0.7933	
12	2.40	5.12	5.25	0.638	0.276	2.70E-03	0.0000	-0.5593	
13	4.00	6.31	6.41	0.617					
14	6.80	7.58	8.50	0.595	0.782	8.15E-03	0.2000	-0.1070	
15	12.00	10.30	11.25	0.548	1.379	1.94E-03	0.4722	0.13966	
16	20.00	13.50	14.10	0.493	2.299	2.29E-03	0.4375	0.36151	
17	34.00	16.80	17.55	0.436	3.908	2.13E-03	0.3182	0.59195	
18	15.00	17.23	17.21	0.429	1.724	1.02E-03	0.0125	0.23657	
19	4.25	16.18	16.13	0.447	0.489	2.07E-03	0.0074	-0.3111	
20	1.00	14.20	14.10	0.481	0.115	6.04E-03	0.0105	-0.9395	
21	0.10	10.75	10.65	0.541	0.011	1.62E-04	0.2703	-1.9395	
21	seating	9.25	9.19	0.567	0.000	1.92E-05	0.0400		

(Data stored on diskette No. gld35a).

(Skeleton spreadsheet last revised: 9 Jan. 1990, gy)



SAMPLE DESCRIPTION Stiff gray green silty CLAY,
trace fine sand, with occasional sand partings
and gravel

ATTERBURG LIMITS (%) W_N 28.5
 W_L 33.6
 W_p 16.8
 I_p 16.8

BORING NO. B89-3
SAMPLE NO. U4
DEPTH (FEET) 43.3
ELEVATION -29.9
DATUM NGVD

	WATER CONTENT (%)	VOID RATIO, e
INITIAL	<u>28.5</u>	<u>0.726</u>
FINAL	<u>27.1</u>	<u>0.568</u>

PRECONSOLIDATION PRESSURE, σ_p' (TSF) 8.7
COMPRESSION RATIO, CR 0.144
RECOMPRESSION RATIO, RR 0.006



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ROUGHANS POINT
REVERE, MASSACHUSETTS

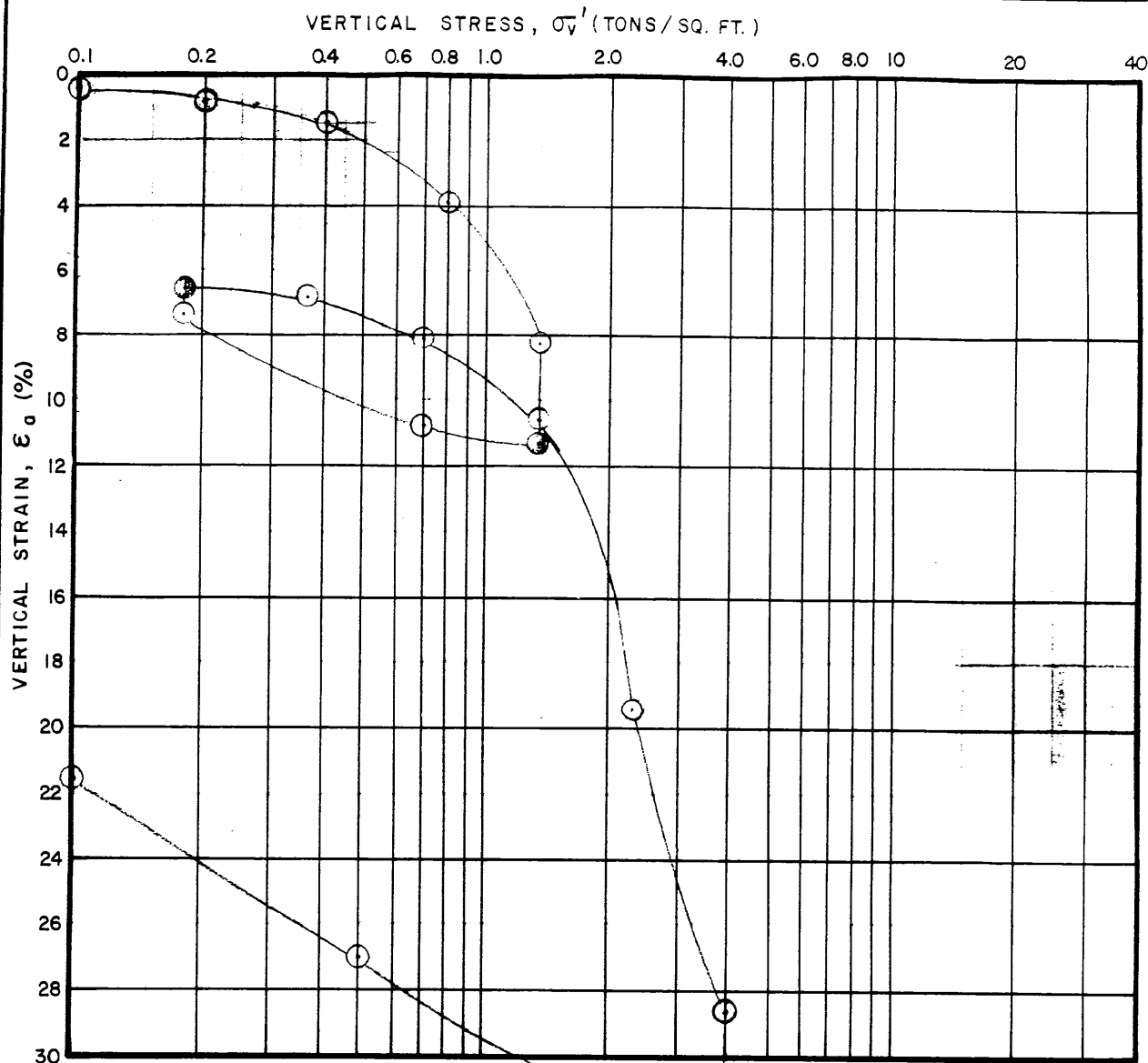
CONSOLIDATION TEST NO. OED2

FILE NO. 10259-01

H & A FORM NO. 520 JAN.1986

HALEY & ALDRICH, INC.		CONSOLIDATION TEST SUMMARY				FILE No. 10259-01				
PROJECT: Roughans Point Revere, Massachusetts						DATE: Jan. 1990				
EXPL. No.: TP89-105		SAMPLE DESCRIPTION: Medium stiff to stiff dark brown fibrous PEAT				TEST No. OED3				
SAMPLE No.: Block 1						CALC. BY: FJF				
DEPTH (ft.): 6.6		ATTERBERG LIMITS (%): wL = 186.5 IP = 73.3 wP = 113.2 IL = 0.2				CHCKD.BY: GY				
						STRESS STRAIN PARAMETERS:				
INITIAL FINAL Test Quality : () Excellent						Preconsolidation				
WATER CONTENT (%) 128.58 111.89 () Very Good						Pressure, sig'p 1.0 tsf				
DEG. OF SAT. (%) 89.0 100.0 (X) Good						CR = 0.484				
SAMPLE HT. (cm) 1.896 1.564 () Fair						RR = 0.047				
SAMPLE DIAMETER (cm) 6.340 () Poor										
SAMPLE AREA (sq.cm) 31.570						Overburden				
WET SAMPLE WT. (g) 73.490		NOTES: 1. CR and RR calculated as the change in strain divided by the change in log stress.				Stress, sig'vo= _____ tsf				
DRY SAMPLE WT. (g) 32.150						Vertical Strain				
TOT. UNIT WT. (pcf) 76.6		2. Specific gravity estimated assuming final degree of saturation S = 100%				at sig'vo= _____ %				
EST. SPECIFIC GRAVITY 2.400										
VOID RATIO, e 3.468 2.685										
SOLIDS HT. (cm) 0.424										
INC. No.	VERT. STRESS (tsf)	VERTICAL STRAIN (%) (EOP)	VERTICAL STRAIN (%) (EOI)	VOID RATIO, e (EOP)	VOID RATIO, e (EOI)	STRESS RATIO (sig'vc/ sig'p)	COEFF. CONS., cv (sqcm/sec)	COEFF. SEC. COMP. (%)	LOG STRESS RATIO log (sig'vc/ sig'p)	REMARKS
1	0.06	0.13	0.15	3.462	0.060	1.96E-03	0.0185		-1.2218	
2	0.10	0.24	0.37	3.457	0.100	1.31E-03	0.1357		-1	
3	0.20	0.72	1.06	3.436	0.200	2.33E-03	0.1618		-0.6989	
4	0.40	1.78	2.16	3.389	0.400	3.19E-03	0.2513		-0.3979	
5	0.80	3.97	4.43	3.291	0.800	1.85E-03	0.4563		-0.0969	
6	1.40	8.20	11.69	3.102	1.400	7.40E-04	3.0682		0.14612	
7	0.70	10.81	10.51	2.985	0.700	1.03E-03	0.2568		-0.1549	
8	0.18	7.74	6.59	3.122	0.180	3.48E-04	0.7991		-0.7447	
9	0.36	6.93	7.07	3.158	0.360	2.05E-03	0.1016		-0.4436	
10	0.70	8.01	8.94	3.110	0.700	1.80E-03	0.3505		-0.1549	
11	1.40	10.80	12.96	2.986	1.400	1.07E-03	0.8975		0.14612	
12	2.40	19.52	22.89	2.596	2.400	1.03E-04	2.9523		0.38021	
13	4.00	27.19	31.70	2.253	4.000	1.84E-04	2.7222		0.60205	
14	2.00	30.98	30.66	2.084	2.000	5.35E-04	0.1708		0.30102	
15	0.50	27.02	25.90	2.261	0.500	5.98E-05	0.9706		-0.3010	
16	0.10	21.65	21.17	2.501	0.100	2.45E-05	2.3920		-1	
17	seating		17.25							

H & A FORM NO. 520 JAN.1986



SAMPLE DESCRIPTION

Stiff dark brown PEAT

BORING NO. TP89-5

SAMPLE NO. BLOCK 1

DEPTH (FEET) 6.6

ELEVATION -3.4

DATUM NGVD

ATTERBERG LIMITS (%)

W_N 128.6
 W_L 186.5
 W_P 113.2
 I_P 73.3

WATER
CONTENT (%)

VOID
RATIO, e

INITIAL 123.6 3.468

FINAL 111.9 2.685

PRECONSOLIDATION
PRESSURE, σ_p' (TSF) 1.0

COMPRESSION RATIO, CR 0.484

RECOMPRESSION RATIO, RR 0.047



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ROUGHANS POINT
REVERE, MASSACHUSETTS

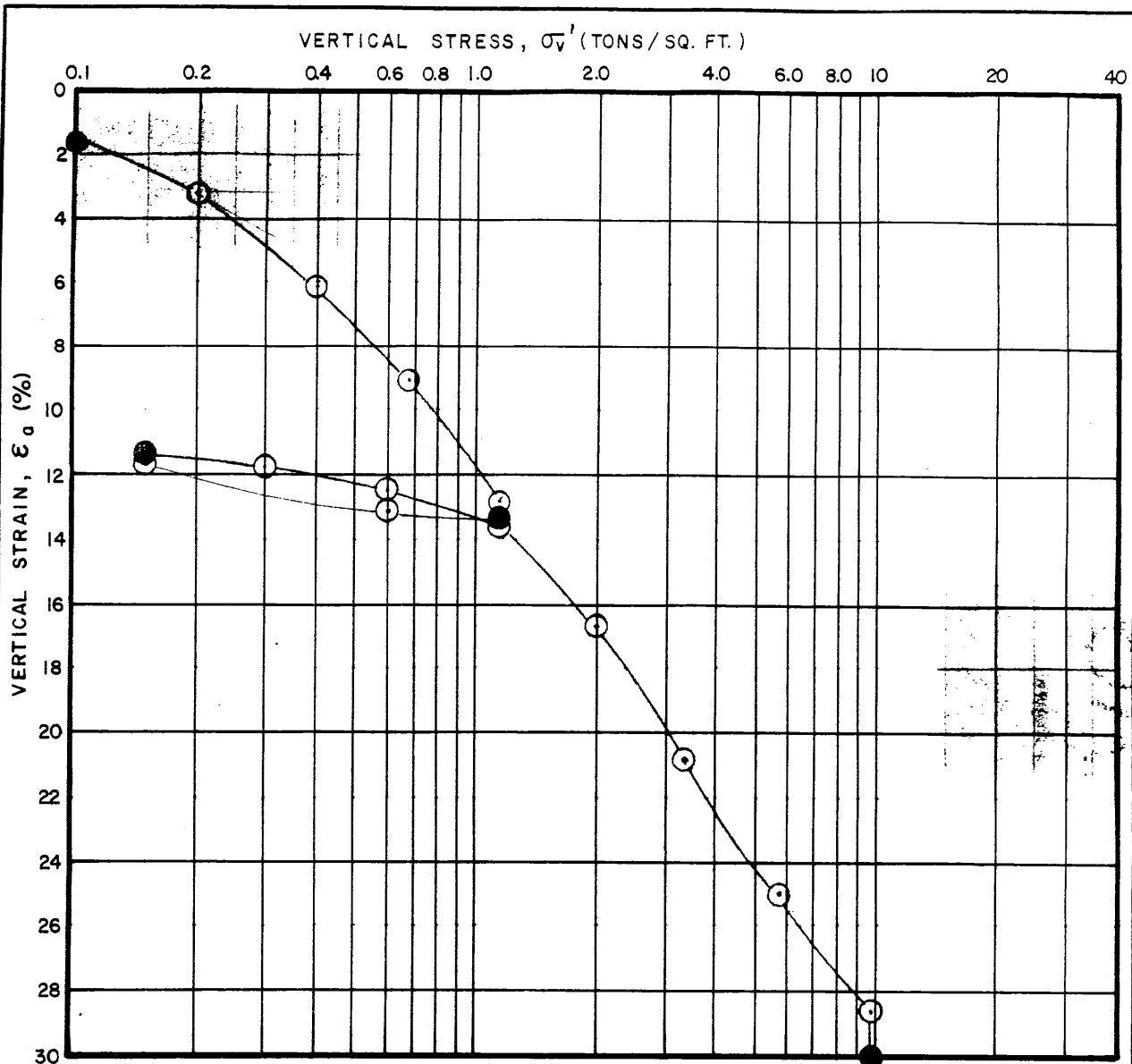
CONSOLIDATION TEST NO. OED3

FILE NO. 10259-01

HALEY & ALDRICH, INC.		CONSOLIDATION TEST SUMMARY				FILE No. 10259-01			
PROJECT: Roughans Point Revere, Massachusetts						DATE: FEB 1990			
EXPL. No.: B89-4		SAMPLE DESCRIPTION: Very soft to soft ORGANIC CLAY				TEST No. OED4			
SAMPLE No.: U2						CALC. BY: gy			
DEPTH (ft.): 12.8		ATTERBERG LIMITS (%): WL = 93.8 IP = 65.5 WP = 28.3 IL = 0.5				CHCKD.BY: gy			
						STRESS STRAIN PARAMETERS:			
INITIAL FINAL Test Quality : () Excellent						Preconsolidation			
WATER CONTENT (%) 58.95 39.15 () Very Good						Pressure, sig'p 0.45 tsf			
DEG. OF SAT. (%) 95.3 100.0 (x) Good						CR = 0.169			
SAMPLE HT. (cm) 1.905 1.463 () Fair						RR = 0.024			
SAMPLE DIAMETER (cm) 6.353 () Poor									
SAMPLE AREA (sq.cm) 31.699		NOTES: 1. CR and RR calculated as the change in strain divided by the change in log stress 2. Specific gravity estimated assuming final degree of saturation S = 100%				Overburden			
WET SAMPLE WT. (g) 97.960						Stress, sig'vo= _____ tsf			
DRY SAMPLE WT. (g) 61.630						Vertical Strain			
TOT. UNIT WT. (pcf) 101.3						at sig'vo= _____ %			
EST. SPECIFIC GRAVITY 2.770									
VOID RATIO, e 1.714 1.085									
SOLIDS HT. (cm) 0.702									
INC. No.	VERT. STRESS (tsf)	VERTICAL STRAIN (%) (EOP)	VERTICAL STRAIN (%) (EOI)	VOID RATIO, e (sig'vc/ sig'p) (EOP)	STRESS RATIO (sig'vc/ sig'p)	COEFF. CONS., cv (sqcm/sec)	COEFF. SEC. COMP. (%)	LOG STRESS RATIO log (sig'vc/ sig'p)	REMARKS
1	0.06		0.76						
2	0.10		1.56						
3	0.20	3.42	4.05	1.621	0.444	2.52E-04	1.0500	-0.3521	
4	0.40	6.04	6.80	1.550	0.889	3.97E-04	1.1300	-0.0511	
5	0.68	9.00	10.40	1.470	1.511	2.83E-04	1.3000	0.17929	
6	1.20	12.70	13.39	1.369	2.667	3.29E-04	1.3300	0.42596	
7	0.60	13.17	13.16	1.357	1.333	1.59E-03	0.0050	0.12493	
8	0.15	11.83	11.62	1.393	0.333	3.45E-04	0.1400	-0.4771	
9	0.30	11.88	12.04	1.392	0.667	1.46E-03	0.0650	-0.1760	
10	0.60	12.60	12.89	1.372	1.333	1.41E-03	0.1340	0.12493	
11	1.20	13.70	14.89	1.342	2.667	1.48E-03	0.4500	0.42596	
12	2.00	16.60	18.10	1.264	4.444	4.17E-04	0.9600	0.64781	
13	3.40	20.90	22.45	1.147	7.556	3.32E-04	0.9500	0.87826	
14	5.78	24.80	26.00	1.041	12.844	2.98E-04	0.9500	1.10871	
15	9.83	28.50	30.00	0.941	21.844	4.65E-04	1.2000	1.33934	
16	4.92	29.84	29.77	0.904	10.933	3.67E-03	0.0260	1.03875	
17	1.23	29.02	28.62	0.926	2.733	1.00E-03	0.1950	0.43669	
18	0.15	26.18	25.50	1.004	0.333	8.24E-04	0.7600	-0.4771	
19	seating		23.18						

(Data stored on diskette No. gld17).

(Skeleton spreadsheet last revised: 9 Jan. 1990, gy)



SAMPLE DESCRIPTION Soft brown ORGANIC CLAY,
with gravel

BORING NO. B89-4

SAMPLE NO. U2

DEPTH (FEET) 26.8

ELEVATION -8.4

DATUM NGVD

ATTERBERG LIMITS (%)

W_N	59.0
W_L	93.8
W_P	28.3
I_P	65.5

	WATER CONTENT (%)	VOID RATIO, e
INITIAL	59.0	1.714
FINAL	39.2	1.085

PRECONSOLIDATION PRESSURE, σ_p' (TSF) 0.45

COMPRESSION RATIO, CR 0.169

RECOMPRESSION RATIO, RR 0.024



Haley & Aldrich, Inc.

Consulting Geotechnical Engineers, Geologists and Hydrogeologists

ROUGHANS POINT

REVERE, MASSACHUSETTS

CONSOLIDATION TEST NO. OED4

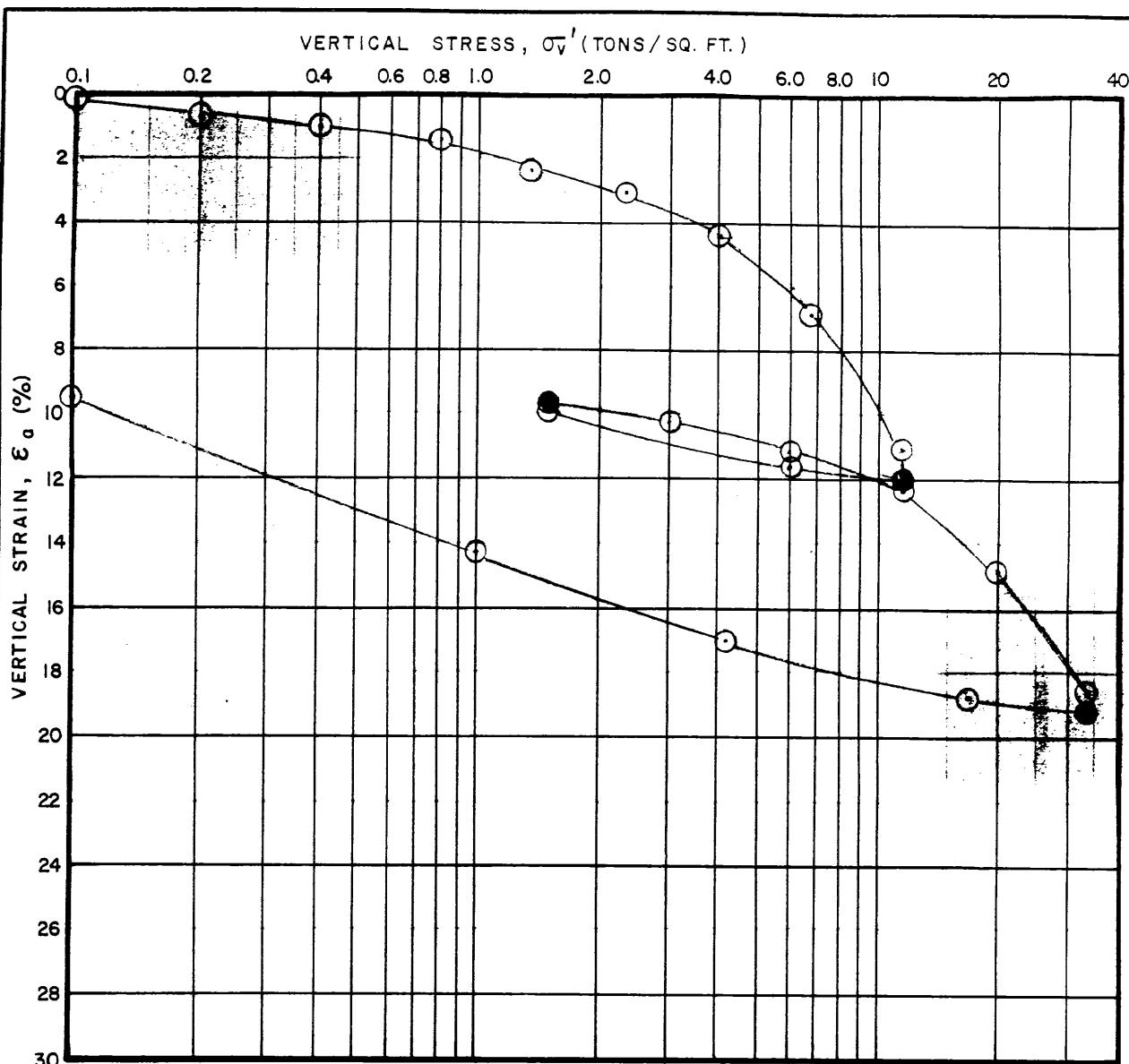
FILE NO. 10259-01

HALEY & ALDRICH, INC.				CONSOLIDATION TEST SUMMARY					
PROJECT: Roughans Point Revere, Massachusetts								FILE No.	10259-01
								DATE:	FEB 1990
								TEST No.	OED5
								CALC. BY:	gy
								CHCKD.BY:	gy
EXPL. No.:	B89-4	SAMPLE DESCRIPTION: Stiff gray green silty CLAY with fine sand partings							
SAMPLE No.:	U4								
DEPTH (ft.)	54.2	ATTERBERG LIMITS (%): wL = 50.5 IP = 26.0 wP = 24.5 IL = 0.5							
								STRESS STRAIN PARAMETERS:	
INITIAL FINAL Test Quality : () Excellent									
WATER CONTENT (%) 36.57 34.90 () Very Good								Preconsolidation	
DEG. OF SAT. (%) 89.7 100.0 (x) Good								Pressure, sig'p 5.0 tsf	
SAMPLE HT. (cm) 1.905 1.755 () Fair								CR = 0.159	
SAMPLE DIAMETER (cm) 6.347 () Poor								RR = 0.027	
SAMPLE AREA (sq.cm) 31.639									
WET SAMPLE WT. (g) 110.850								Overburden	
DRY SAMPLE WT. (g) 81.170								Stress, sig'vo= _____ tsf	
TOT. UNIT WT. (pcf) 114.8								Vertical Strain	
EST. SPECIFIC GRAVITY 2.987								at sig'vo= _____ %	
VOID RATIO, e 1.218 1.043									
SOLIDS HT. (cm) 0.859									
NOTES: 1. CR and RR calculated as the change in strain divided by the change in log stress									
2. Specific gravity estimated assuming final degree of saturation S = 100%									

INC. No.	VERT. STRESS (tsf)	VERTICAL STRAIN (%) (EOP)	VOID RATIO, e (EOP)	STRESS RATIO (sig'vc/ sig'p)	COEFF. CONS., cv	COEFF. SEC. COMPR. (%)	LOG STRESS RATIO log (sig'vc/ sig'p)	REMARKS	
1	0.06	0.04							
2	0.10	0.13	0.14	1.215	0.020	4.71E-03	0.0200	-1.6989	
3	0.20	0.57	0.58	1.205	0.040	2.96E-03	0.0030	-1.3979	
4	0.40	0.95	1.00	1.197	0.080	1.85E-03	0.0450	-1.0969	
5	0.80	1.58	1.66	1.183	0.160	3.65E-03	0.0700	-0.7958	
6	1.40	2.21	2.36	1.169	0.280	2.49E-03	0.0700	-0.5528	
7	2.40	3.00	3.22	1.151	0.480	2.82E-03	0.1500	-0.3187	
8	4.00	4.42	4.90	1.120	0.800	1.74E-03	0.2350	-0.0969	
9	6.80	6.90	7.59	1.065	1.360	1.32E-03	0.5800	0.13353	
10	12.00	11.20	12.00	0.970	2.400	1.09E-03	0.3750	0.38021	
11	6.00	11.58	11.53	0.961	1.200	4.62E-03	0.0250	0.07918	
12	1.50	9.97	9.81	0.997	0.300	1.33E-03	0.1400	-0.5228	
13	3.00	10.20	10.23	0.992	0.600	2.41E-03	0.0256	-0.2218	
14	6.00	11.08	11.15	0.972	1.200	2.99E-03	0.0450	0.07918	
15	12.00	12.32	12.60	0.945	2.400	3.43E-03	0.2000	0.38021	
16	20.00	14.88	14.50	0.888	4.000	1.25E-03	0.4800	0.60205	
17	34.00	18.55	19.20	0.807	6.800	3.07E-04	0.6000	0.83250	
18	17.00	18.79	18.72	0.801	3.400	6.18E-03	0.0300	0.53147	
19	4.25	17.02	16.90	0.840	0.850	1.42E-03	0.1100	-0.0705	
20	1.00	14.20	14.02	0.903	0.200	3.78E-04	0.1700	-0.6989	
21	0.10	9.75	9.50	1.002	0.020	1.16E-04	0.4000	-1.6989	
22	seating	7.90							

(Data stored on diskette No. gld17).

(Skeleton spreadsheet last revised: 9 Jan. 1990, gy)



SAMPLE DESCRIPTION Stiff gray green CLAY, with
frequent fine sand partings

BORING NO. B89-4

SAMPLE NO. U4

DEPTH (FEET) 54.2

ELEVATION -35.8

DATUM NGVD

ATTENDED UNITS (%)

W_N	36.6
W_L	50.5
W_P	24.5
I_P	26.0

	WATER CONTENT (%)	VOID RATIO, e
INITIAL	36.6	1.218
FINAL	34.9	1.043

PRECONSOLIDATION PRESSURE, σ_p' (TSF) 5.0

COMPRESSION RATIO, CR 0.159

RECOMPRESSION RATIO, RR 0.027



Haley & Aldrich, Inc.
 Consulting Geotechnical Engineers, Geologists and Hydrogeologists

ROUGHANS POINT
 REVERE, MASSACHUSETTS

CONSOLIDATION TEST NO. OED5

FILE NO. 10259-01

H & A FORM NO. 520 JAN. 1986

HALEY & ALDRICH, INC.

UNCONSOLIDATED UNDRAINED COMPRESSION TEST SUMMARY

TEST No. UU1

PROJECT: Roughans Point
Revere, Massachusetts

FILE No. 10259-01

DATE Dec. 1989

SAMPLE DESCRIPTION: Dark gray ORGANIC
CLAY

EXPLORATION No.: B89-3

SAMPLE No.: U1

DEPTH (ft.): 22.3

ATTERBERG LIMITS: WL= 62.0 IP= 34.2
WP= 27.8 IL= 0.6

SAMPLE DIMENSIONS:

	PRESHEAR	FINAL
height (cm)	7.970	7.149
diameter (cm)	3.537	3.898
area (sq. cm)	9.826	11.934
volume (cc)	78.3102	85.3137

SAMPLE QUALITY

(x) GOOD
() FAIR
() POOR

DISPLACEMENT RATE (mm/min) 0.0619
AXIAL STRAIN RATE (%/hour) 4.66

	48.68	44.55
WATER CONTENT (%)		

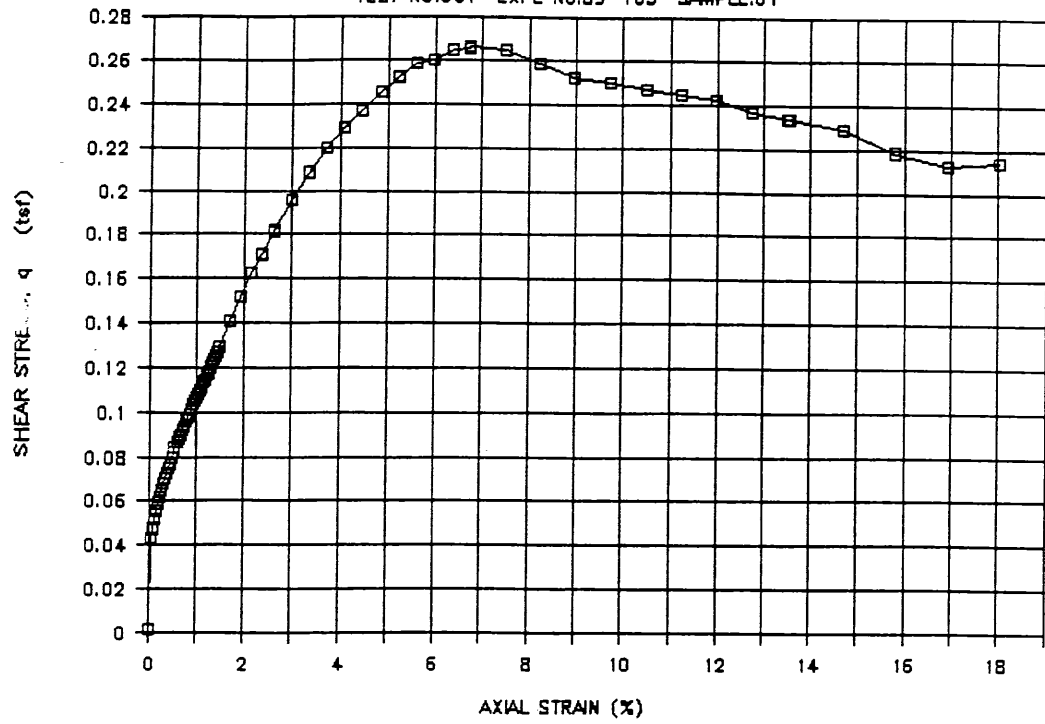
TOTAL UNIT
WEIGHT (pcf): 108.8

PEAK UNDRAINED
SHEAR STRENGTH,
cu (tsf) : 0.266

ENTRY No.	AXIAL STRAIN (%)	SHEAR STRESS, q (tsf)	AVG. EFFECTIVE STRESS, p' (tsf)	AVG. TOTAL STRESS, p (tsf)	PORE PRESSURE, u (tsf)	STRESS RATIO, q/p'	PORE PRESS. PARAM. A	SECANT YOUNG'S MODULUS, E (tsf)	REMARKS
1	0.000	0.0018	0.0227	0.9892	0.9665	0.0793			
2	0.109	0.0515	0.0676	1.0390	0.9714	0.7627	0.0487	94.7	
3	0.219	0.0621	0.0673	1.0495	0.9822	0.9223	0.1299	56.6	
4	0.328	0.0705	0.0743	1.0579	0.9836	0.9481	0.1240	42.9	
5	0.438	0.0768	0.0794	1.0642	0.9848	0.9670	0.1218	35.1	
6	0.544	0.0841	0.0863	1.0716	0.9853	0.9754	0.1139	30.9	
7	0.655	0.0899	0.0913	1.0773	0.9861	0.9849	0.1107	27.5	
8	0.765	0.0964	0.0976	1.0839	0.9863	0.9885	0.1044	25.2	
9	0.877	0.1011	0.1021	1.0886	0.9864	0.9902	0.1001	23.1	
10	0.987	0.1066	0.0996	1.0940	0.9944	1.0698	0.1328	21.6	
11	1.098	0.1115	0.1055	1.0990	0.9935	1.0577	0.1229	20.3	
12	1.210	0.1167	0.1111	1.1041	0.9930	1.0502	0.1152	19.3	
13	1.322	0.1227	0.1176	1.1101	0.9925	1.0433	0.1074	18.6	
14	1.433	0.1273	0.1230	1.1147	0.9918	1.0353	0.1005	17.8	
15	1.698	0.1408	0.1301	1.1283	0.9981	1.0820	0.1135	16.6	
16	2.374	0.1711	0.1676	1.1585	0.9909	1.0207	0.0719	14.4	
17	2.976	0.1963	0.1944	1.1837	0.9893	1.0095	0.0585	13.2	
18	4.093	0.2295	0.2313	1.2170	0.9857	0.9924	0.0420	11.2	
19	5.206	0.2523	0.2677	1.2397	0.9720	0.9424	0.0109	9.7	
20	5.972	0.2604	0.2820	1.2478	0.9658	0.9233	-0.0014	8.7	
21	6.724	0.2654	0.2943	1.2528	0.9585	0.9016	-0.0153	7.9	
22	7.485	0.2651	0.3019	1.2526	0.9506	0.8781	-0.0302	7.1	
23	8.971	0.2524	0.3013	1.2398	0.9385	0.8375	-0.0560	5.6	
24	10.485	0.2468	0.3026	1.2342	0.9316	0.8156	-0.0713	4.7	
25	11.987	0.2425	0.3016	1.2299	0.9283	0.8039	-0.0795	4.0	
26	13.495	0.2338	0.2926	1.2213	0.9286	0.7991	-0.0817	3.5	
27	13.532	0.2337	0.2867	1.2211	0.9345	0.8153	-0.0691	3.5	
28	16.910	0.2133	0.2624	1.2007	0.9383	0.8129	-0.0667	2.5	
29	17.996	0.1892	0.3706	1.3058	0.9352	0.5106	-0.0866	2.1	

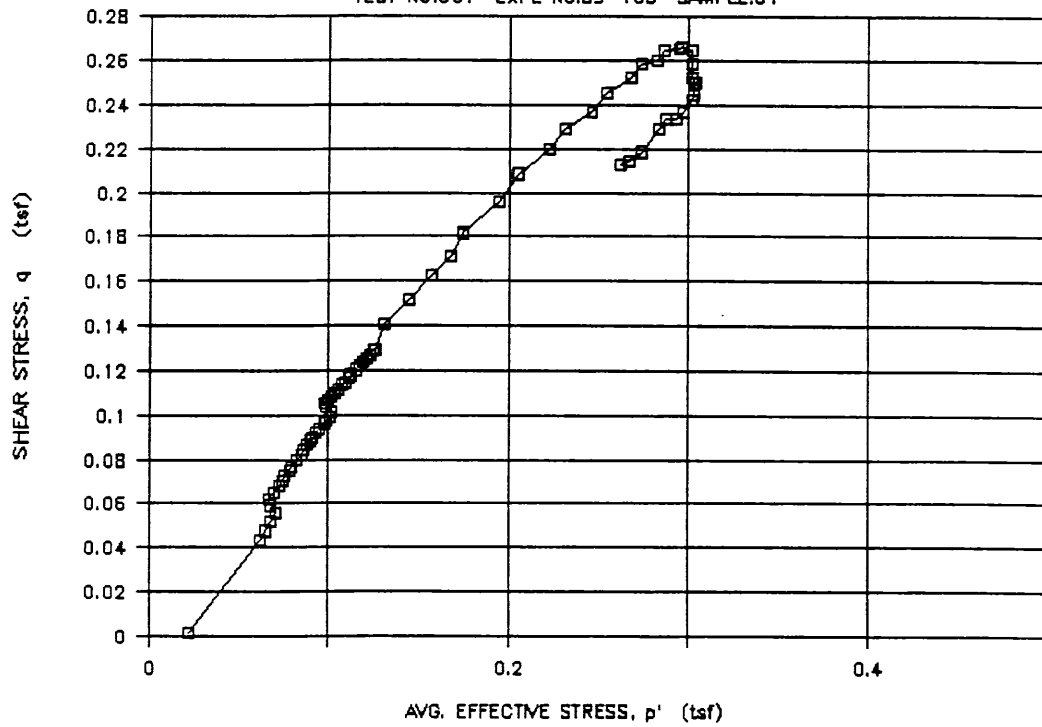
STRESS STRAIN CURVE

TEST No:UU1 EXPL No:89-103 SAMPLE:U1



STRESS PATH

TEST No:UU1 EXPL No:89-103 SAMPLE:U1



FILE NO.

HALEY & ALDRICH, INC.

HALEY & ALDRICH, INC.

UNCONSOLIDATED UNDRAINED COMPRESSION TEST SUMMARY

TEST No. UU2

PROJECT: Roughans Point
Revere, Massachusetts

FILE No. 10259-01

DATE Jan. 1990

SAMPLE DESCRIPTION: Stiff gray green silty CLAY,
trace fine sand.

EXPLORATION No.: B89-3

SAMPLE No.: U4

DEPTH (ft.): 42.4

ATTERBERG LIMITS: wL= 33.6 IP= 16.8
wP= 16.8 IL= 0.5

SAMPLE DIMENSIONS:

	PRESHEAR	FINAL
height (cm)	7.959	6.780
diameter (cm)	3.634	3.972
area (sq. cm)	10.372	12.391
volume (cc)	82.5502	84.0114

SAMPLE QUALITY

() GOOD

(x) FAIR

() POOR

DISPLACEMENT RATE (mm/min) 0.0595
AXIAL STRAIN RATE (%/hour) 4.49

WATER CONTENT (%)

25.33

24.36

TOTAL UNIT

WEIGHT (pcf): 126.5

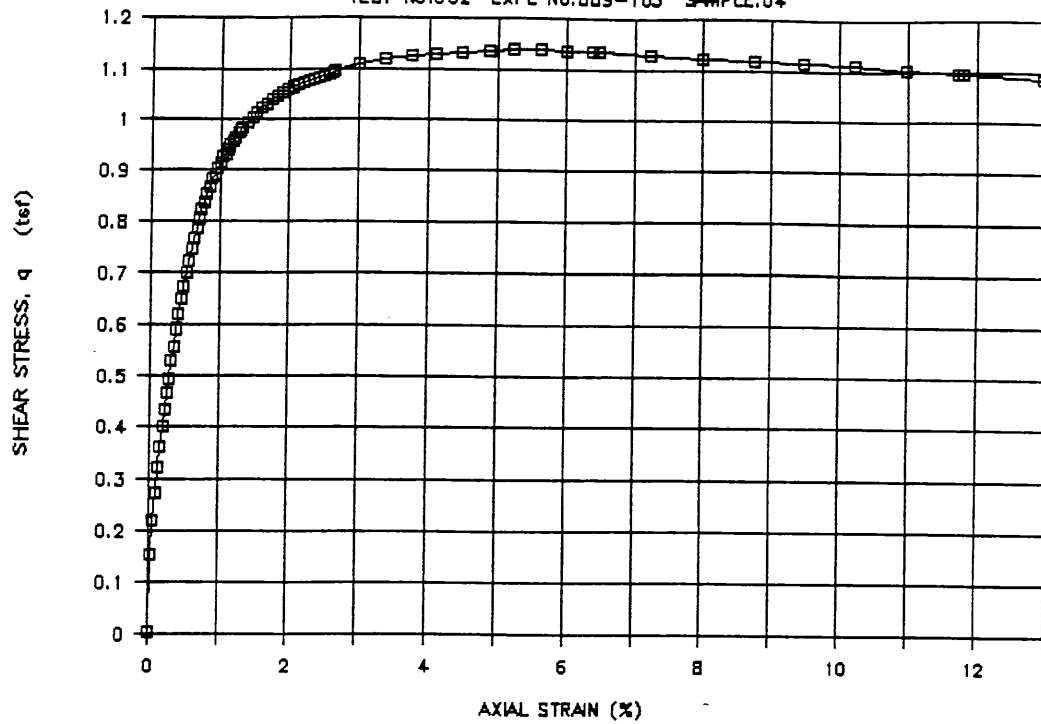
PEAK UNDRAINED
SHEAR STRENGTH,
cu (tsf):

1.138

ENTRY No.	AXIAL STRAIN (%)	SHEAR STRESS, q (tsf)	AVG. EFFECTIVE STRESS, p' (tsf)	AVG. TOTAL STRESS, p (tsf)	PORE PRESSURE, u (tsf)	STRESS RATIO, q/p'	PORE PRESS. PARAM. A	SECANT YOUNG'S MODULUS, E (tsf)	REMARKS
1	0.000	0.0017	0.9506	0.8617	-0.0889	0.0018			
2	0.099	0.2740	1.1923	1.1339	-0.0584	0.2298	0.0561	552.3	* PORE PRESSURE READINGS NOT RELIABLE
3	0.198	0.4010	1.3025	1.2610	-0.0415	0.3079	0.0594	405.8	
4	0.285	0.4960	1.3810	1.3560	-0.0250	0.3592	0.0647	347.6	
5	0.385	0.5923	1.4617	1.4523	-0.0095	0.4052	0.0673	308.0	
6	0.491	0.6730	1.5272	1.5330	0.0058	0.4407	0.0706	274.0	
7	0.601	0.7467	1.5869	1.6067	0.0197	0.4705	0.0729	248.5	
8	0.710	0.8047	1.6323	1.6647	0.0324	0.4930	0.0756	226.7	
9	0.818	0.8541	1.6707	1.7140	0.0433	0.5112	0.0776	208.8	
10	0.926	0.8908	1.6978	1.7507	0.0529	0.5246	0.0798	192.3	
11	1.038	0.9247	1.7224	1.7846	0.0622	0.5368	0.0819	178.1	
12	1.147	0.9478	1.7374	1.8077	0.0703	0.5455	0.0842	165.2	
13	1.258	0.9713	1.7540	1.8312	0.0772	0.5537	0.0857	154.4	
14	1.379	0.9934	1.7697	1.8534	0.0837	0.5613	0.0870	144.0	
15	1.600	1.0221	1.7892	1.8821	0.0929	0.5713	0.0891	127.7	
16	1.822	1.0465	1.8069	1.9065	0.0996	0.5792	0.0902	114.9	
17	2.044	1.0638	1.8184	1.9238	0.1054	0.5850	0.0915	104.1	
18	2.265	1.0755	1.8271	1.9355	0.1084	0.5887	0.0919	95.0	
19	2.485	1.0861	1.8366	1.9461	0.1095	0.5914	0.0915	87.4	
20	2.631	1.0931	1.8426	1.9530	0.1104	0.5932	0.0913	83.1	
21	3.002	1.1075	1.8581	1.9675	0.1094	0.5960	0.0897	73.8	
22	3.738	1.1256	1.8853	1.9855	0.1002	0.5970	0.0842	60.2	
23	4.487	1.1317	1.9050	1.9917	0.0867	0.5941	0.0777	50.4	
24	5.242	1.1378	1.9230	1.9978	0.0748	0.5917	0.0720	43.4	
25	6.002	1.1361	1.9322	1.9961	0.0640	0.5880	0.0674	37.9	
26	6.476	1.1339	1.9361	1.9939	0.0577	0.5857	0.0648	35.0	
27	7.232	1.1270	1.9386	1.9870	0.0484	0.5814	0.0610	31.2	
28	9.475	1.1149	1.9405	1.9749	0.0344	0.5745	0.0554	23.5	
29	11.727	1.0951	1.9292	1.9550	0.0258	0.5676	0.0525	18.7	
30	12.951	1.0002	1.9855	2.0081	0.0226	0.5038	0.0476	15.4	

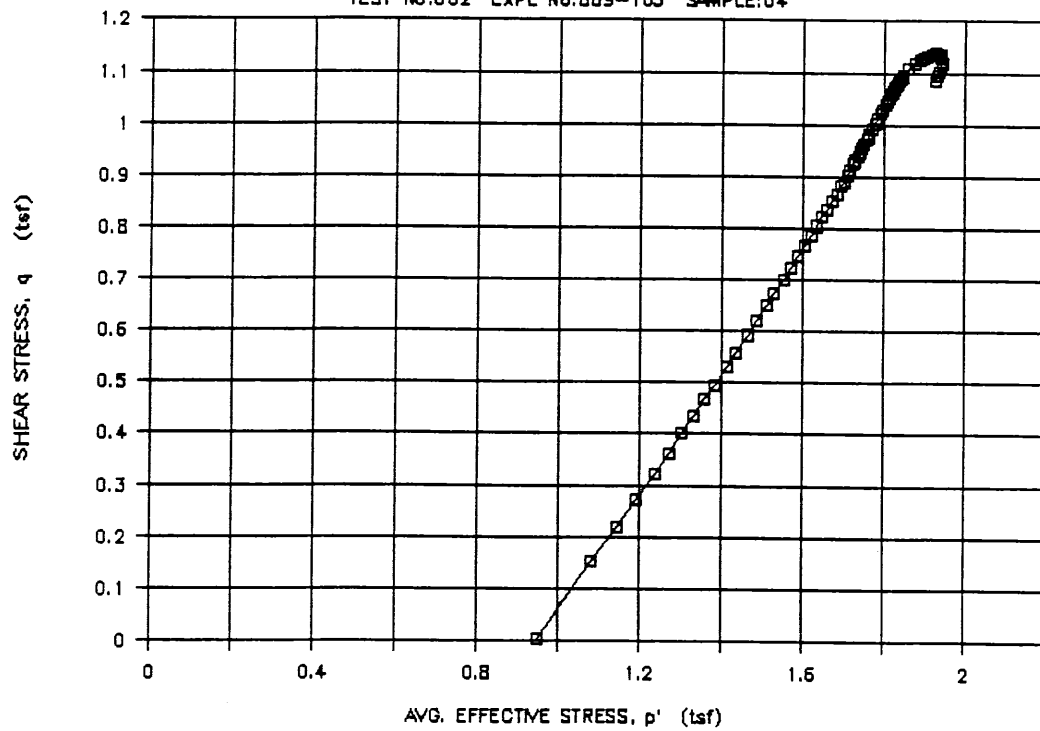
STRESS STRAIN CURVE

TEST No:UU2 EXPL No:889-103 SAMPLE:U4



STRESS PATH

TEST No:UU2 EXPL No:889-103 SAMPLE:U4



FILE NO.

HALEY & ALDRICH, INC.

HALEY & ALDRICH, INC.

UNCONSOLIDATED UNDRAINED COMPRESSION TEST SUMMARY

TEST No. UU3

PROJECT: Roughans Point
Revere, Massachusetts

FILE No. 10259-01

DATE JAN 1990

SAMPLE DESCRIPTION: Dark brown PEAT

EXPLORATION No.: TP89-5
SAMPLE No.: Block 1
DEPTH (ft.): 6.3

ATTERBERG LIMITS: wL= 186.5 IP= 73.3
wP= 113.2 IL= 0.1

SAMPLE DIMENSIONS:

	PRESHEAR	FINAL
height (cm)	7.867	6.911
diameter (cm)	3.514	3.629
area (sq. cm)	9.698	10.343
volume (cc)	76.2961	71.4833

SAMPLE QUALITY

() GOOD
(X) FAIR
() POOR

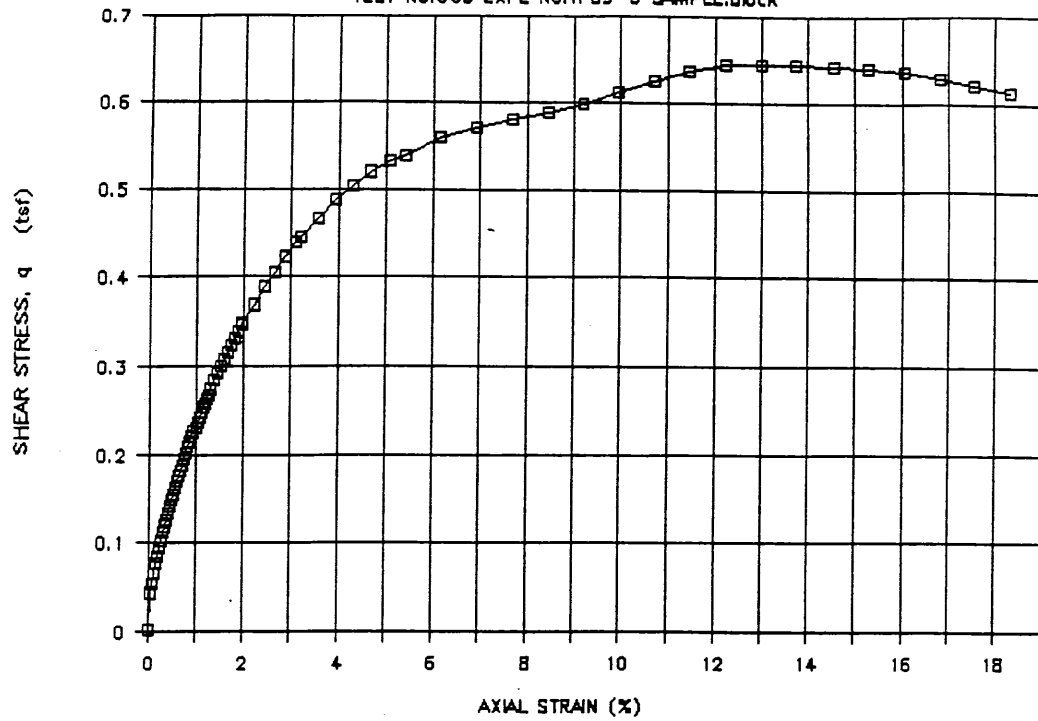
DISPLACEMENT RATE (mm/min) 0.0596
AXIAL STRAIN RATE (%/hour) 4.54

	WATER CONTENT (%)	121.69	118.69	TOTAL UNIT WEIGHT (pcf):	81.7	PEAK UNDRAINED SHEAR STRENGTH, cu (tsf) :	0.645
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ENTRY No.	AXIAL STRAIN (%)	SHEAR STRESS, q (tsf)	AVG. EFFECTIVE STRESS, p' (tsf)	AVG. TOTAL STRESS, p (tsf)	PORE PRESSURE, u (tsf)	STRESS RATIO, q/p'	PORE PRESS. PARAM. A	SECANT YOUNG'S MODULUS, E (tsf)	REMARKS
1	0.000	0.0018	0.4273	0.6500	0.2227	0.0043			
2	0.109	0.0657	0.4527	0.7139	0.2612	0.1451	0.3015	120.0	
3	0.223	0.0950	0.4634	0.7432	0.2798	0.2051	0.3065	85.3	
4	0.337	0.1193	0.4692	0.7675	0.2983	0.2544	0.3218	70.9	
5	0.450	0.1410	0.4748	0.7891	0.3144	0.2969	0.3294	62.6	
6	0.531	0.1558	0.4784	0.8039	0.3255	0.3256	0.3340	58.7	
7	0.643	0.1765	0.4837	0.8247	0.3409	0.3649	0.3385	54.9	
8	0.758	0.1959	0.4882	0.8441	0.3559	0.4012	0.3431	51.7	
9	0.870	0.2144	0.4922	0.8626	0.3704	0.4356	0.3473	49.3	
10	0.985	0.2313	0.4954	0.8795	0.3842	0.4670	0.3518	47.0	
11	1.098	0.2480	0.4950	0.8962	0.4012	0.5010	0.3626	45.2	
12	1.210	0.2635	0.4951	0.9117	0.4166	0.5322	0.3704	43.5	
13	1.362	0.2838	0.4987	0.9320	0.4334	0.5692	0.3735	41.7	
14	1.585	0.3077	0.5002	0.9559	0.4557	0.6152	0.3809	38.8	
15	1.809	0.3317	0.5048	0.9799	0.4751	0.6571	0.3825	36.7	
16	1.974	0.3486	0.5014	0.9968	0.4955	0.6954	0.3932	35.3	
17	2.648	0.4051	0.5036	1.0532	0.5496	0.8042	0.4053	30.6	
18	3.187	0.4453	0.5039	1.0935	0.5896	0.8837	0.4136	27.9	
19	4.314	0.5036	0.5193	1.1518	0.6324	0.9697	0.4083	23.3	
20	5.065	0.5326	0.5325	1.1807	0.6482	1.0001	0.4009	21.0	
21	6.148	0.5592	0.5514	1.2074	0.6560	1.0142	0.3887	18.2	
22	7.680	0.5804	0.5637	1.2285	0.6648	1.0295	0.3821	15.1	
23	9.199	0.5982	0.5773	1.2464	0.6691	1.0361	0.3742	13.0	
24	10.714	0.6251	0.6006	1.2733	0.6726	1.0407	0.3610	11.7	
25	12.230	0.6445	0.6237	1.2927	0.6689	1.0332	0.3472	10.5	
26	13.749	0.6454	0.6223	1.2936	0.6713	1.0371	0.3485	9.4	
27	14.521	0.6433	0.6189	1.2915	0.6725	1.0393	0.3506	8.9	
28	18.316	0.6135	0.5910	1.2769	0.6706	1.0380	0.3662	6.7	

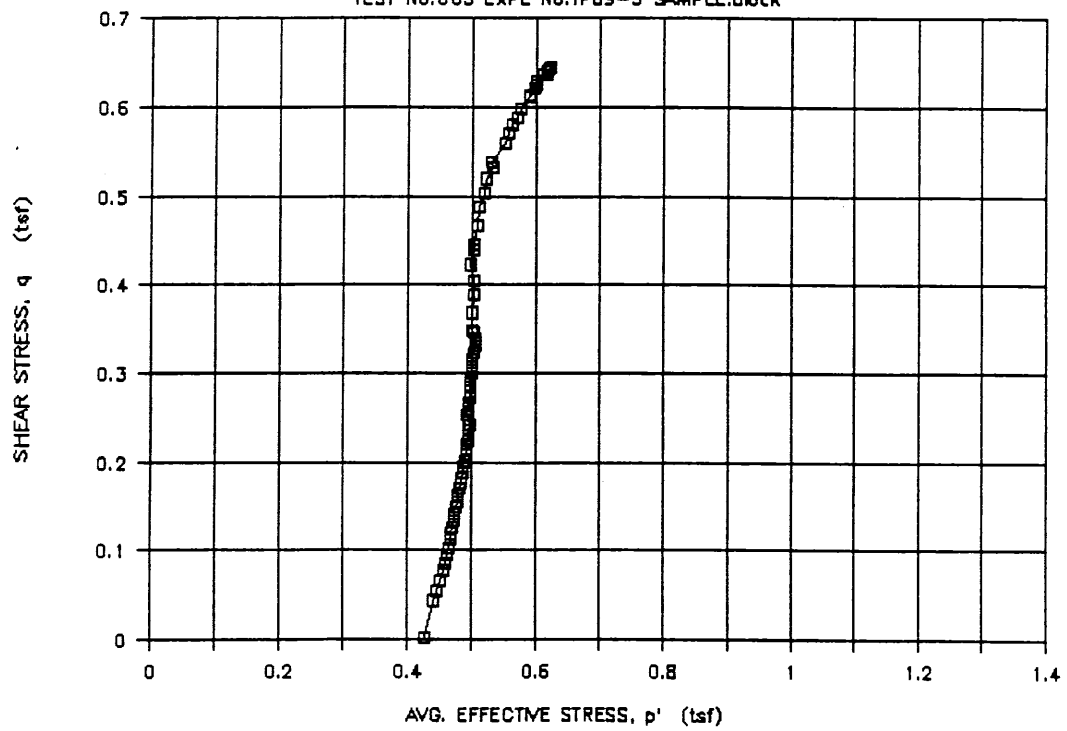
STRESS STRAIN CURVE

TEST No:UU3 EXPL No:TP89-5 SAMPLE:Block



STRESS PATH

TEST No:UU3 EXPL No:TP89-5 SAMPLE:Block



FILE NO.

HALEY & ALDRICH, INC.

HALEY & ALDRICH, INC.

UNCONSOLIDATED UNDRAINED COMPRESSION TEST SUMMARY

TEST No. UU4

PROJECT: Roughans Point
Revere, Massachusetts

FILE No. 10259-01

DATE JAN 1990

SAMPLE DESCRIPTION: Soft gray brown ORGANIC CLAY

EXPLORATION No.: B89-4

SAMPLE No.: U2

DEPTH (ft.) 13.0

ATTERBERG LIMITS: WL= 93.8 IP= 65.5
WP= 28.3 IL= 0.9

SAMPLE DIMENSIONS:

PRESHEAR FINAL
height (cm) 7.443 6.449
diameter (cm) 3.580 3.718
area (sq. cm) 10.066 10.857
volume (cc) 74.9211 70.0166

SAMPLE QUALITY

() GOOD
() FAIR
(x) POOR

DISPLACEMENT RATE (mm/min) 0.0585
AXIAL STRAIN RATE (%/hour) 4.72

WATER CONTENT (%) 88.53 88.34

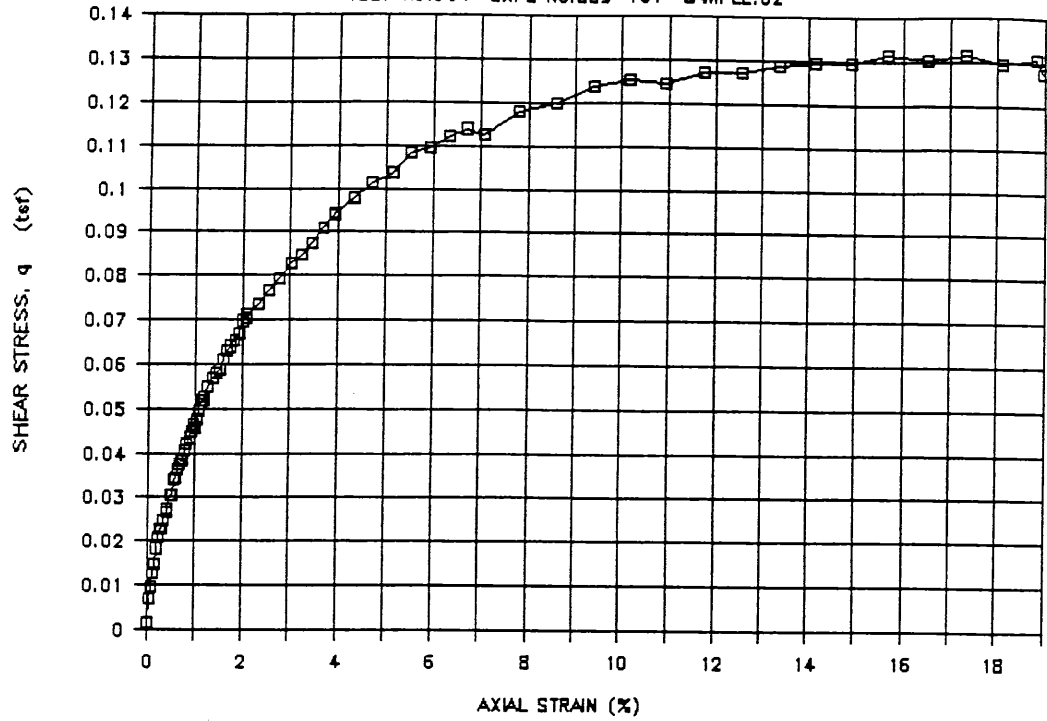
TOTAL UNIT
WEIGHT (pcf): 91.2

PEAK UNDRAINED
SHEAR STRENGTH,
cu (tsf) : 0.132

ENTRY No.	AXIAL STRAIN (%)	SHEAR STRESS, q (tsf)	AVG. EFFECTIVE STRESS, p' (tsf)	AVG. TOTAL STRESS, p (tsf)	PORE PRESSURE, u (tsf)	STRESS RATIO, q/p'	PORE PRESS. PARAM. A	SECANT YOUNG'S MODULUS, E (tsf)	REMARKS
1	0.000	0.0016	0.0648	0.6664	0.6016	0.0241			
2	0.118	0.0129	0.0713	0.6777	0.6064	0.1808	0.2132	21.8	
3	0.240	0.0210	0.0686	0.6858	0.6172	0.3060	0.4023	17.5	
4	0.358	0.0248	0.0716	0.6897	0.6181	0.3471	0.3550	13.9	
5	0.476	0.0305	0.0754	0.6954	0.6200	0.4052	0.3182	12.8	
6	0.595	0.0344	0.0769	0.6992	0.6223	0.4468	0.3160	11.5	
7	0.711	0.0385	0.0794	0.7033	0.6239	0.4849	0.3028	10.8	
8	0.830	0.0423	0.0812	0.7072	0.6260	0.5212	0.2995	10.2	
9	0.950	0.0464	0.0834	0.7112	0.6278	0.5556	0.2922	9.8	
10	1.072	0.0496	0.0812	0.7145	0.6332	0.6108	0.3293	9.3	
11	1.193	0.0529	0.0817	0.7177	0.6360	0.6472	0.3358	8.9	
12	1.354	0.0568	0.0858	0.7217	0.6359	0.6626	0.3105	8.4	
13	1.596	0.0612	0.0887	0.7260	0.6373	0.6896	0.2996	7.7	
14	1.829	0.0655	0.0917	0.7304	0.6387	0.7148	0.2902	7.2	
15	2.068	0.0711	0.0893	0.7359	0.6466	0.7957	0.3238	6.9	
16	2.549	0.0766	0.0934	0.7414	0.6480	0.8200	0.3096	6.0	
17	3.235	0.0849	0.0970	0.7497	0.6527	0.8753	0.3071	5.2	
18	3.931	0.0940	0.1033	0.7588	0.6555	0.9098	0.2919	4.8	
19	4.723	0.1017	0.1100	0.7665	0.6565	0.9244	0.2745	4.3	
20	5.520	0.1084	0.1156	0.7733	0.6577	0.9379	0.2624	3.9	
21	6.310	0.1125	0.1254	0.7773	0.6519	0.8972	0.2271	3.6	
22	7.041	0.1127	0.1238	0.7775	0.6538	0.9106	0.2349	3.2	
23	8.596	0.1201	0.1333	0.7849	0.6516	0.9005	0.2110	2.8	
24	10.187	0.1255	0.1413	0.7903	0.6490	0.8880	0.1915	2.5	
25	11.736	0.1275	0.1406	0.7924	0.6518	0.9075	0.1995	2.2	
26	13.348	0.1290	0.1529	0.7939	0.6410	0.8440	0.1547	1.9	
27	14.132	0.1298	0.1525	0.7947	0.6422	0.8513	0.1582	1.8	
28	16.501	0.1306	0.1574	0.7955	0.6381	0.8299	0.1414	1.6	
29	18.846	0.1311	0.1536	0.7959	0.6423	0.8532	0.1572	1.4	
30	18.969	0.1277	0.1522	0.7926	0.6404	0.8393	0.1538	1.3	

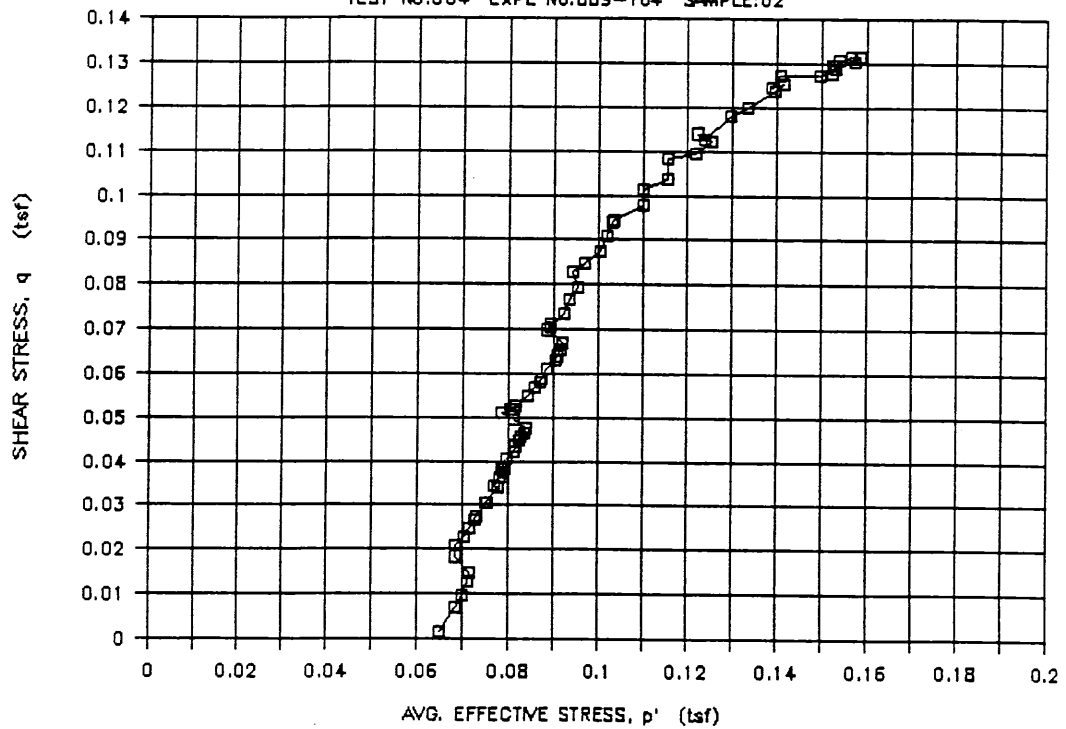
STRESS STRAIN CURVE

TEST No:UU4 EXPL No:889-104 SAMPLE:U2



STRESS PATH

TEST No:UU4 EXPL No:889-104 SAMPLE:U2



HALEY & ALDRICH, INC.

UNCONSOLIDATED UNDRAINED COMPRESSION TEST SUMMARY

TEST No. UU5

PROJECT: Roughans Point
Revere, Massachusetts

FILE No. 10259-01

DATE JAN 1990

SAMPLE DESCRIPTION: Stiff gray green silty CLAY
with medium to fine sand seams

EXPLORATION No.:889-4

SAMPLE No.: U4

DEPTH (ft.) 54.5

ATTERBERG LIMITS: wL= 50.5 IP= 26.0
wP= 24.5 IL= 0.5

SAMPLE DIMENSIONS:

	PRESHEAR	FINAL
height (cm)	7.920	6.870
diameter (cm)	3.599	4.109
area (sq. cm)	10.173	13.261
volume (cc)	80.5710	91.1001

SAMPLE QUALITY

()GOOD
(x)FAIR
()POOR

DISPLACEMENT RATE (mm/min) 0.0594
AXIAL STRAIN RATE (%/hour) 4.50

WATER CONTENT (%) 37.41 38.27

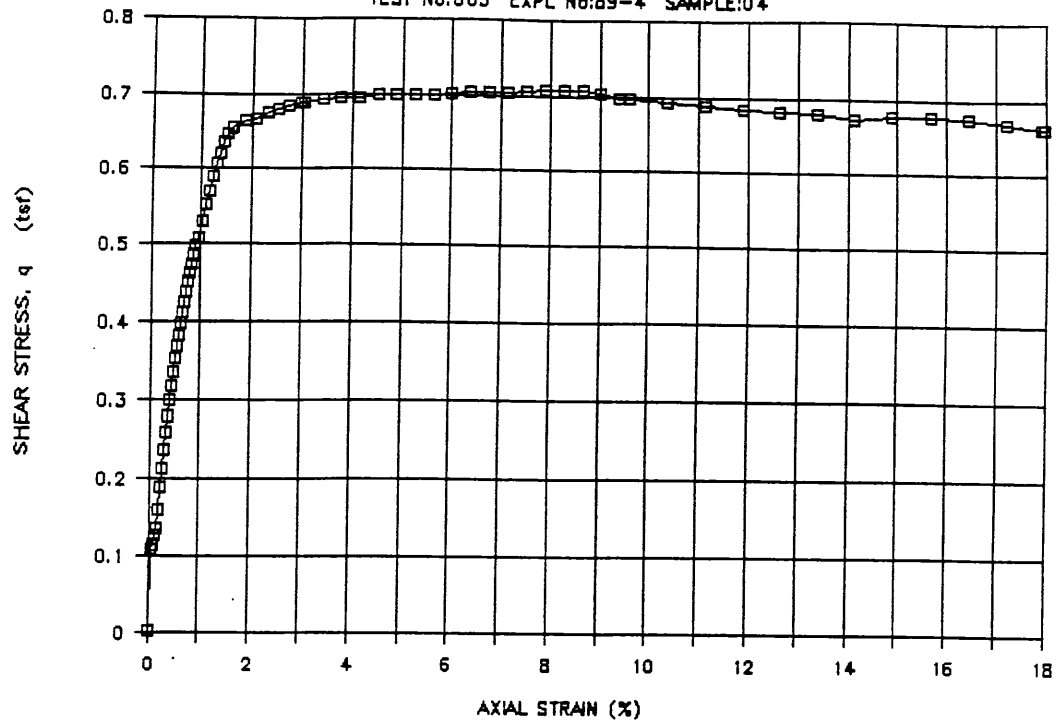
TOTAL UNIT
WEIGHT (pcf): 117.6

PEAK UNDRAINED
SHEAR STRENGTH,
cu (tsf) : 0.709

ENTRY No.	AXIAL STRAIN (%)	SHEAR STRESS, q (tsf)	AVG. EFFECTIVE STRESS, p' (tsf)	AVG. TOTAL STRESS, p (tsf)	PORE PRESSURE, u (tsf)	STRESS RATIO, q/p'	PORE PRESS. PARAM. A	SECANT YOUNG'S MODULUS, E (tsf)	REMARKS
1	0.000	0.0015	0.6490	0.7041	0.0551	0.0024			
2	0.106	0.1261	0.7614	0.8286	0.0672	0.1656	0.0489	237.9	
3	0.214	0.1880	0.7974	0.8905	0.0931	0.2358	0.1021	175.9	
4	0.328	0.2589	0.8294	0.9615	0.1321	0.3122	0.1496	157.7	
5	0.435	0.3198	0.8551	1.0223	0.1672	0.3740	0.1762	146.9	
6	0.541	0.3697	0.8744	1.0723	0.1978	0.4228	0.1939	136.6	
7	0.647	0.4119	0.8902	1.1145	0.2243	0.4628	0.2062	127.3	
8	0.752	0.4509	0.9059	1.1535	0.2476	0.4978	0.2142	120.0	
9	0.858	0.4859	0.9209	1.1885	0.2676	0.5277	0.2194	113.3	
10	1.006	0.5290	0.9413	1.2315	0.2902	0.5619	0.2229	105.1	
11	1.228	0.5886	0.9739	1.2911	0.3172	0.6043	0.2233	95.9	
12	1.447	0.6344	1.0050	1.3369	0.3319	0.6312	0.2187	87.7	
13	1.616	0.6555	1.0199	1.3580	0.3381	0.6427	0.2164	81.1	
14	2.291	0.6740	1.0424	1.3766	0.3342	0.6466	0.2075	58.8	
15	2.953	0.6888	1.0735	1.3914	0.3178	0.6416	0.1912	46.6	
16	3.780	0.6959	1.1015	1.3985	0.2970	0.6318	0.1742	36.8	
17	4.886	0.6987	1.1296	1.4012	0.2716	0.6185	0.1553	28.6	
18	5.997	0.7015	1.1504	1.4040	0.2536	0.6098	0.1418	23.4	
19	7.124	0.7045	1.1697	1.4071	0.2374	0.6023	0.1297	19.8	
20	7.888	0.7075	1.1808	1.4101	0.2293	0.5992	0.1234	17.9	
21	8.646	0.7087	1.1898	1.4113	0.2215	0.5957	0.1177	16.4	
22	9.404	0.6976	1.1826	1.4002	0.2176	0.5899	0.1167	14.8	
23	10.376	0.6917	1.1821	1.3942	0.2121	0.5851	0.1138	13.3	
24	11.895	0.6838	1.1751	1.3863	0.2113	0.5819	0.1145	11.5	
25	13.378	0.6791	1.1779	1.3816	0.2038	0.5765	0.1097	10.2	
26	14.892	0.6771	1.1881	1.3796	0.1915	0.5698	0.1010	9.1	
27	15.666	0.6772	1.1931	1.3797	0.1866	0.5676	0.0974	8.6	
28	17.925	0.6623	1.1845	1.3648	0.1803	0.5591	0.0948	7.4	
29	17.994	0.6625	1.1858	1.3651	0.1793	0.5587	0.0940	7.4	

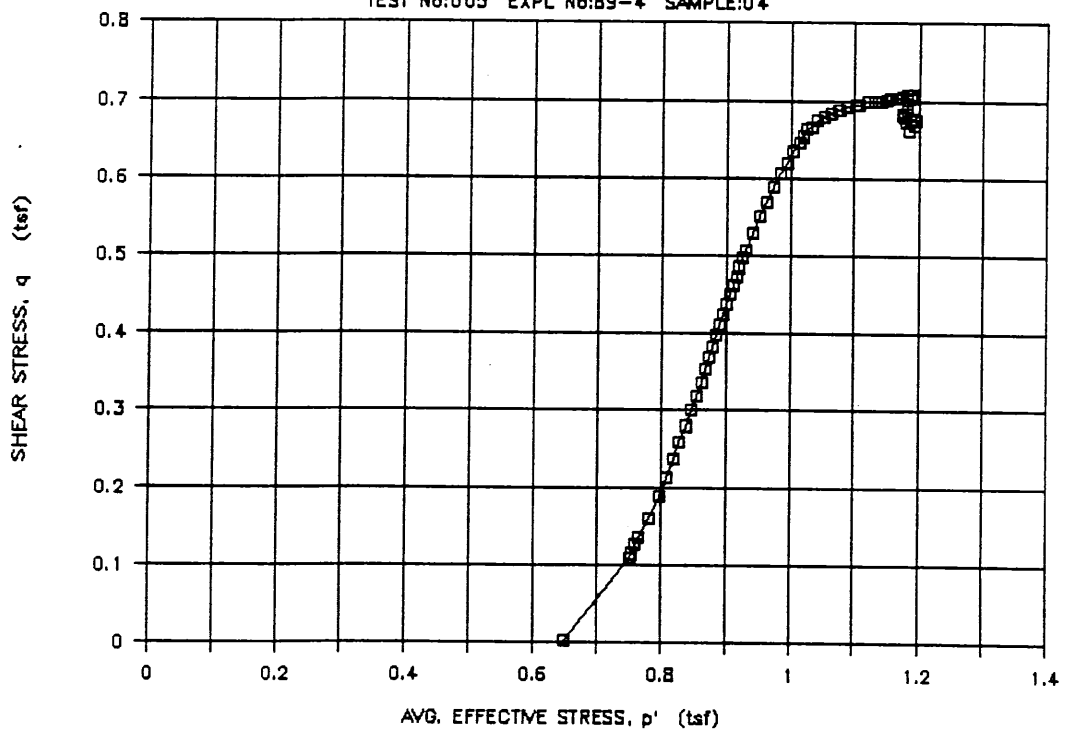
STRESS STRAIN CURVE

TEST No:UU5 EXPL No:B9-4 SAMPLE:U4



STRESS PATH

TEST No:UU5 EXPL No:B9-4 SAMPLE:U4



FILE NO.

HALEY & ALDRICH, INC.

HALEY & ALDRICH, INC.

UNCONSOLIDATED UNDRAINED COMPRESSION TEST SUMMARY

TEST No. UU6

PROJECT: Roughans Point
Revere, Massachusetts

FILE No. 10259-01

DATE Feb. 1990

SAMPLE DESCRIPTION: Stiff gray green silty CLAY

EXPLORATION No.:889-2

SAMPLE No.: U3

DEPTH (ft.) 35.8

ATTERBERG LIMITS: WL= 42.6 IP= 25.1
WP= 17.5 IL= 0.5

SAMPLE DIMENSIONS:

PRESHEAR FINAL
height (cm) 7.947 6.883
diameter (cm) 3.635 4.032
area (sq. cm) 10.378 12.768
volume (cc) 82.4711 87.8838

SAMPLE QUALITY

(x)GOOD
()FAIR
()POOR

DISPLACEMENT RATE (mm/min) 0.0596
AXIAL STRAIN RATE (%/hour) 4.50

WATER CONTENT (%)

28.98 29.40

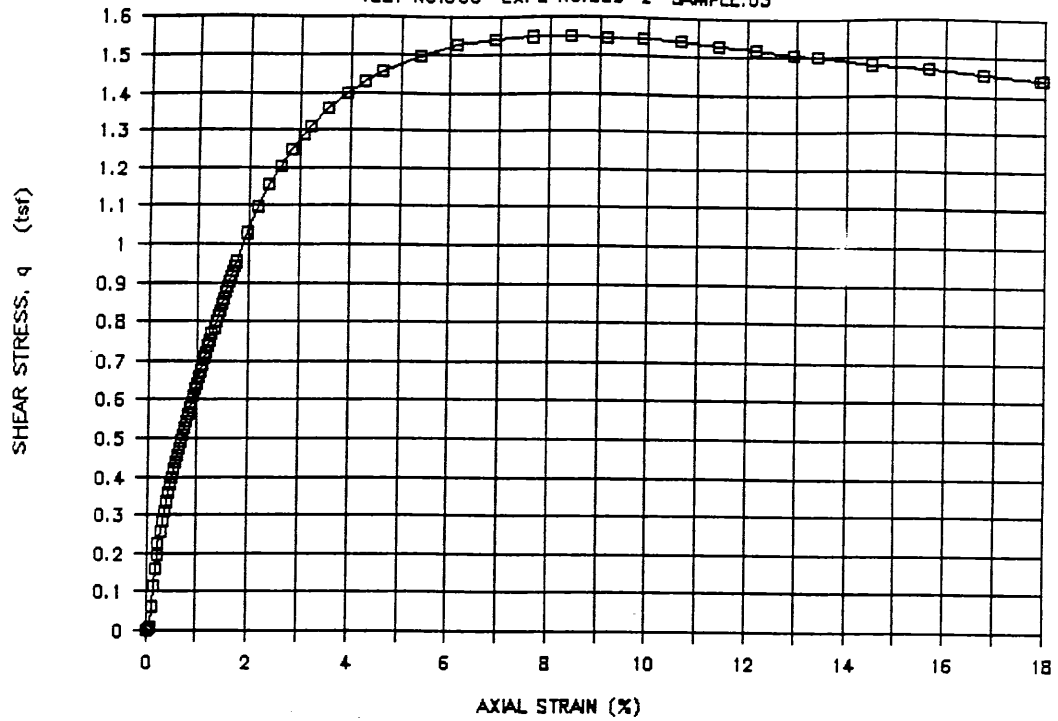
TOTAL UNIT
WEIGHT (pcf): 125.0

PEAK UNDRAINED
SHEAR STRENGTH,
cu (tsf) : 1.548

ENTRY No.	AXIAL STRAIN (%)	SHEAR STRESS, q (tsf)	AVG. EFFECTIVE STRESS, p' (tsf)	AVG. TOTAL STRESS, p (tsf)	PORE PRESSURE, u (tsf)	STRESS RATIO, q/p'	PORE PRESS. PARAM. A	SECANT YOUNG'S MODULUS, E (tsf)	REMARKS
1	0.000	0.0015	1.0264	1.0625	0.0361	0.0015			
2	0.105	0.0627	1.0767	1.1236	0.0469	0.0582	0.0884	119.6	
3	0.205	0.1954	1.1807	1.2564	0.0757	0.1655	0.1020	190.4	
4	0.308	0.2830	1.2413	1.3440	0.1028	0.2280	0.1184	183.6	
5	0.412	0.3576	1.2864	1.4186	0.1321	0.2780	0.1348	173.5	
6	0.520	0.4199	1.3220	1.4809	0.1588	0.3176	0.1467	161.6	
7	0.626	0.4759	1.3535	1.5369	0.1834	0.3516	0.1552	152.0	
8	0.731	0.5277	1.3826	1.5886	0.2060	0.3816	0.1615	144.4	
9	0.843	0.5785	1.4123	1.6395	0.2271	0.4096	0.1655	137.3	
10	0.953	0.6275	1.4416	1.6884	0.2469	0.4353	0.1683	131.7	
11	1.059	0.6751	1.4714	1.7360	0.2647	0.4588	0.1697	127.5	
12	1.167	0.7223	1.5024	1.7832	0.2808	0.4807	0.1698	123.7	
13	1.276	0.7696	1.5343	1.8306	0.2963	0.5016	0.1694	120.7	
14	1.385	0.8151	1.5664	1.8761	0.3097	0.5204	0.1681	117.7	
15	1.495	0.8595	1.5991	1.9204	0.3214	0.5375	0.1662	115.0	
16	1.603	0.9027	1.6320	1.9636	0.3317	0.5531	0.1640	112.6	
17	1.713	0.9448	1.6655	2.0058	0.3403	0.5673	0.1613	110.3	
18	2.173	1.0968	1.7973	2.1578	0.3606	0.6103	0.1481	100.9	
19	2.834	1.2489	1.9590	2.3099	0.3509	0.6375	0.1262	88.1	
20	3.194	1.3090	2.0355	2.3700	0.3345	0.6431	0.1141	82.0	
21	3.930	1.3968	2.1687	2.4578	0.2891	0.6441	0.0907	71.1	
22	4.649	1.4550	2.2746	2.5160	0.2414	0.6397	0.0706	62.6	
23	6.138	1.5264	2.4448	2.5873	0.1426	0.6243	0.0349	49.7	
24	7.658	1.5466	2.5463	2.6076	0.0613	0.6074	0.0081	40.4	
25	9.150	1.5444	2.6127	2.6054	-0.0073	0.5911	-0.0141	33.8	
26	10.638	1.5385	2.6605	2.5995	-0.0611	0.5783	-0.0316	28.9	
27	11.397	1.5273	2.6747	2.5883	-0.0864	0.5710	-0.0401	26.8	
28	13.412	1.4992	2.7002	2.5602	-0.1400	0.5552	-0.0588	22.4	
29	16.770	1.4575	2.7209	2.5185	-0.2024	0.5357	-0.0819	17.4	
30	17.976	1.4429	2.6346	2.5039	-0.1307	0.5477	-0.0882	16.1	

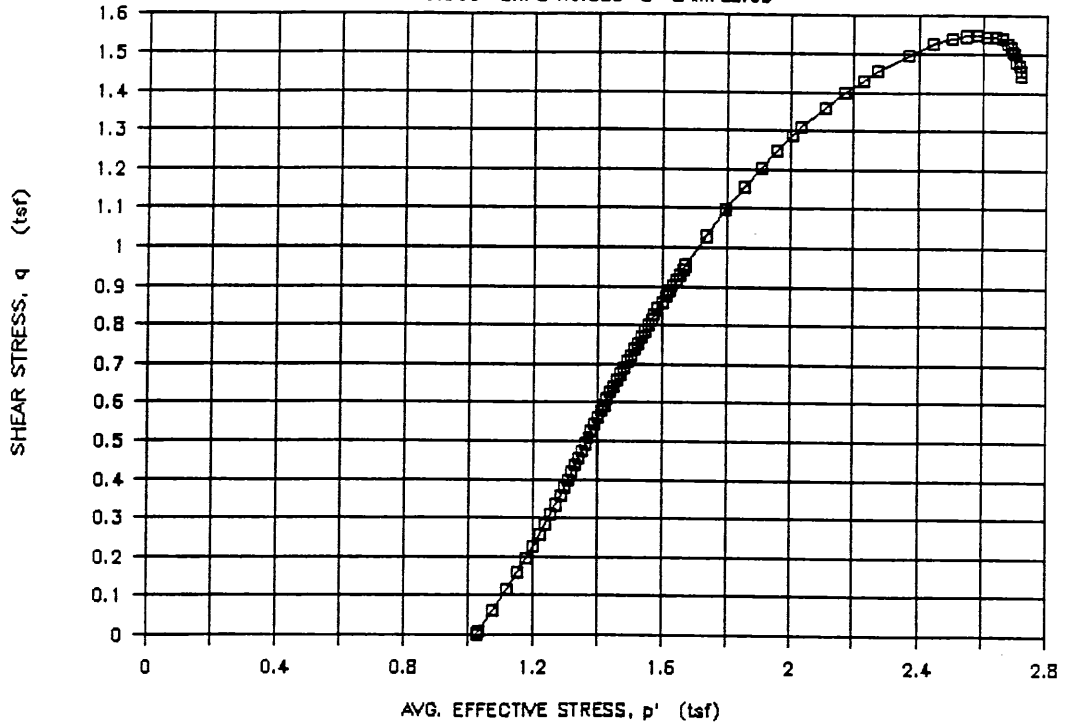
STRESS STRAIN CURVE

TEST No:UU6 EXPL No:BB9-2 SAMPLE:U3



STRESS PATH

TEST No:UU6 EXPL No:BB9-2 SAMPLE:U3



FILE NO.

HALEY & ALDRICH, INC.

HALEY & ALDRICH, INC.

UNCONSOLIDATED UNDRAINED COMPRESSION TEST SUMMARY

TEST No. UU7

PROJECT: Roughans Point
Revere, Massachusetts

FILE No. 10259-01

DATE Feb. 1990

SAMPLE DESCRIPTION: Gray green medium stiff
ORGANIC CLAY.

EXPLORATION No.: 889-2

SAMPLE No.: U1

DEPTH (ft.) 23.75

ATTERBERG LIMITS: WL= 94.4 IP= 60.4
WP= 34.0 IL= 0.4

SAMPLE DIMENSIONS:

	PRESHEAR	FINAL
height (cm)	7.909	6.994
diameter (cm)	3.583	3.811
area (sq. cm)	10.083	11.407
volume (cc)	79.7453	79.7799

SAMPLE QUALITY

(x) GOOD
() FAIR
() POORDISPLACEMENT RATE (mm/min) 0.0598
AXIAL STRAIN RATE (%/hour) 4.54

WATER CONTENT (%)

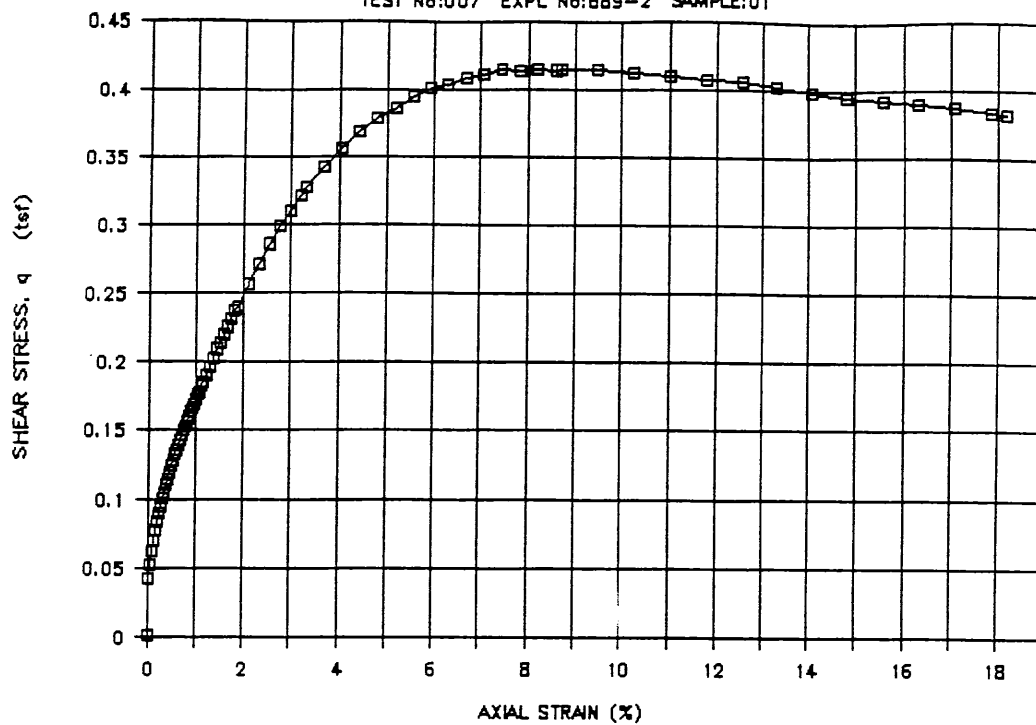
60.25 58.27

TOTAL UNIT
WEIGHT (pcf): 103.8PEAK UNDRAINED
SHEAR STRENGTH,
cu (tsf): 0.415

ENTRY No.	AXIAL STRAIN (%)	SHEAR STRESS, q (tsf)	AVG. EFFECTIVE STRESS, p' (tsf)	AVG. TOTAL STRESS, p (tsf)	PORE PRESSURE, u (tsf)	STRESS RATIO, q/p'	PORE PRESS. PARAM. A	SECANT YOUNG'S MODULUS, E (tsf)	REMARKS
1	0.000	0.0016	0.2152	0.6711	0.4560	0.0073			
2	0.099	0.0621	0.2590	0.7317	0.4726	0.2398	0.1376	125.2	
3	0.203	0.0840	0.2677	0.7536	0.4859	0.3138	0.1813	82.9	
4	0.311	0.1008	0.2735	0.7703	0.4968	0.3684	0.2058	64.9	
5	0.419	0.1144	0.2785	0.7839	0.5054	0.4107	0.2194	54.5	
6	0.526	0.1282	0.2823	0.7977	0.5154	0.4539	0.2346	48.7	
7	0.638	0.1395	0.2881	0.8091	0.5210	0.4843	0.2355	43.8	
8	0.745	0.1502	0.2937	0.8197	0.5260	0.5114	0.2358	40.3	
9	0.854	0.1599	0.2987	0.8295	0.5307	0.5354	0.2361	37.4	
10	0.966	0.1699	0.3044	0.8395	0.5351	0.5582	0.2349	35.2	
11	1.073	0.1786	0.3095	0.8482	0.5386	0.5770	0.2335	33.3	
12	1.219	0.1908	0.3166	0.8604	0.5437	0.6026	0.2318	31.3	
13	1.435	0.2099	0.3262	0.8794	0.5533	0.6435	0.2335	29.3	
14	1.658	0.2259	0.3370	0.8955	0.5585	0.6704	0.2284	27.2	
15	1.872	0.2406	0.3469	0.9102	0.5633	0.6937	0.2245	25.7	
16	2.537	0.2856	0.3775	0.9552	0.5777	0.7566	0.2143	22.5	
17	3.197	0.3210	0.4056	0.9905	0.5849	0.7913	0.2019	20.1	
18	4.046	0.3557	0.4333	1.0252	0.5919	0.8208	0.1920	17.6	
19	5.163	0.3861	0.4619	1.0557	0.5938	0.8360	0.1792	15.0	
20	5.913	0.4004	0.4778	1.0700	0.5922	0.8380	0.1707	13.5	
21	6.679	0.4089	0.4879	1.0784	0.5905	0.8380	0.1652	12.2	
22	7.438	0.4140	0.4963	1.0836	0.5873	0.8343	0.1592	11.1	
23	8.195	0.4148	0.5020	1.0844	0.5824	0.8263	0.1529	10.1	
24	8.701	0.4143	0.5040	1.0839	0.5799	0.8222	0.1502	9.5	
25	10.240	0.4126	0.5091	1.0822	0.5731	0.8105	0.1424	8.1	
26	11.774	0.4075	0.5167	1.0771	0.5604	0.7887	0.1286	6.9	
27	12.547	0.4052	0.5196	1.0748	0.5551	0.7798	0.1228	6.5	
28	14.792	0.3950	0.5181	1.0645	0.5464	0.7623	0.1149	5.3	
29	17.078	0.3873	0.5267	1.0568	0.5301	0.7352	0.0961	4.5	
30	18.175	0.3591	0.5642	1.0908	0.5266	0.6365	0.0988	4.0	

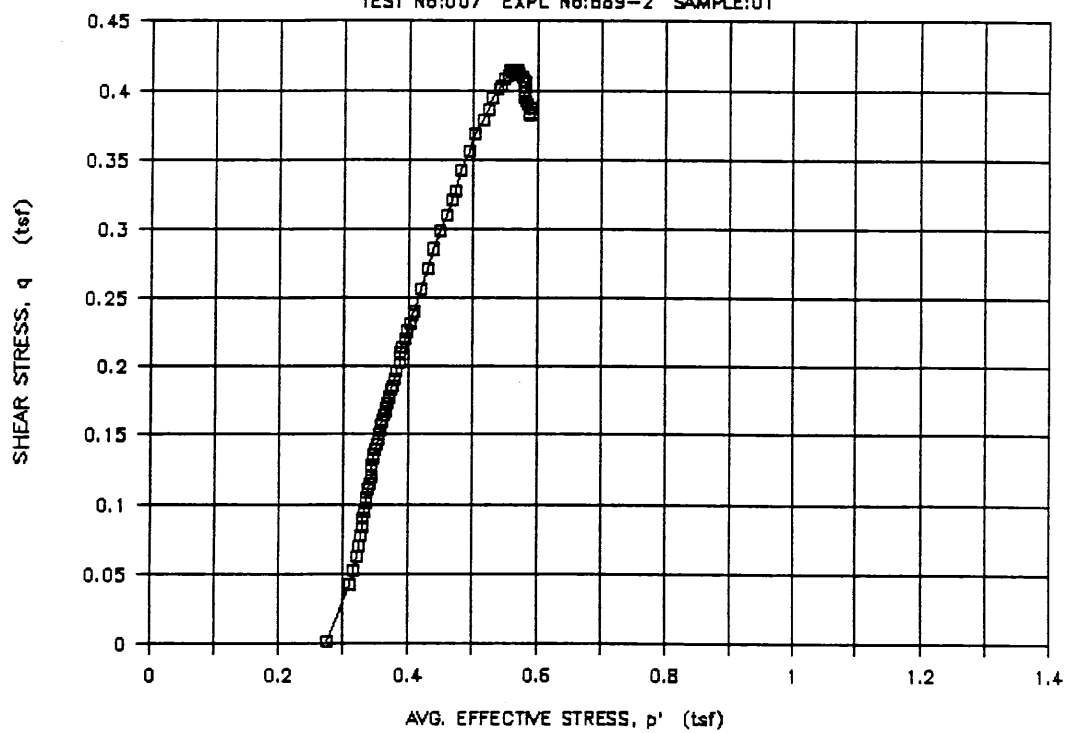
STRESS STRAIN CURVE

TEST No:UU7 EXPL No:889-2 SAMPLE:U1



STRESS PATH

TEST No:UU7 EXPL No:889-2 SAMPLE:U1



FILE NO.

HALEY & ALDRICH, INC.

HALEY & ALDRICH, INC.

UNCONSOLIDATED UNDRAINED COMPRESSION TEST SUMMARY

TEST No. UU 8

PROJECT: Roughans Point
Revere, Massachusetts

FILE No. 10259-01

DATE Feb. 1990

SAMPLE DESCRIPTION: Medium stiff gray brown
ORGANIC CLAY

EXPLORATION No.: B89-2

SAMPLE No.: U2

DEPTH (ft.) 13.8

ATTERBERG LIMITS: WL= 96.1 IP= 64.0
WP= 32.1 IL= 0.5

SAMPLE DIMENSIONS:

	PRESHEAR	FINAL
height (cm)	7.930	6.915
diameter (cm)	3.590	3.861
area (sq. cm)	10.122	11.708
volume (cc)	80.2698	80.9621

SAMPLE QUALITY

(X) GOOD
() FAIR
() POORDISPLACEMENT RATE (mm/min) 0.0602
AXIAL STRAIN RATE (%/hour) 4.55

WATER CONTENT (%)

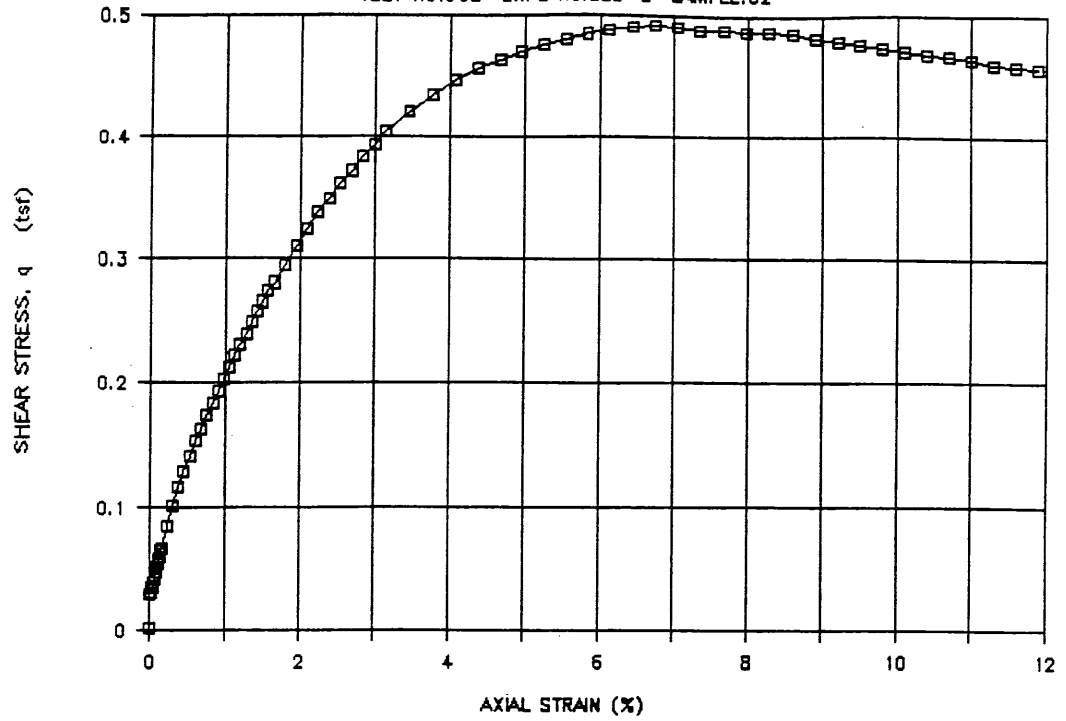
61.31 60.31

TOTAL UNIT
WEIGHT (pcf): 101.5PEAK UNDRAINED
SHEAR STRENGTH,
cu (tsf): 0.493

ENTRY No.	AXIAL STRAIN (%)	SHEAR STRESS, q (tsf)	AVG. EFFECTIVE STRESS, p' (tsf)	AVG. TOTAL STRESS, p (tsf)	PORE PRESSURE, u (tsf)	STRESS RATIO, q/p'	PORE PRESS. PARAM. A	SECANT YOUNG'S MODULUS, E (tsf)	REMARKS
1	0.000	0.0016	0.2504	0.8911	0.6407	0.0063			
2	0.035	0.0341	0.2793	0.9236	0.6443	0.1223	0.0566	196.7	
3	0.058	0.0392	0.2810	0.9286	0.6477	0.1393	0.0931	134.7	
4	0.087	0.0449	0.2831	0.9344	0.6513	0.1587	0.1232	103.6	
5	0.111	0.0515	0.2861	0.9410	0.6549	0.1801	0.1426	92.8	
6	0.135	0.0586	0.2896	0.9481	0.6586	0.2025	0.1571	87.2	
7	0.154	0.0644	0.2920	0.9539	0.6619	0.2206	0.1690	83.4	
8	0.315	0.1012	0.3085	0.9907	0.6822	0.3282	0.2086	64.3	
9	0.533	0.1409	0.3239	1.0304	0.7065	0.4351	0.2364	52.9	
10	0.756	0.1741	0.3398	1.0636	0.7238	0.5124	0.2410	46.1	
11	0.975	0.2040	0.3547	1.0935	0.7388	0.5751	0.2425	41.8	
12	1.200	0.2305	0.3688	1.1200	0.7513	0.6252	0.2416	38.4	
13	1.421	0.2568	0.3826	1.1463	0.7637	0.6712	0.2411	36.1	
14	1.646	0.2800	0.3984	1.1695	0.7711	0.7028	0.2343	34.0	
15	2.092	0.3235	0.4296	1.2130	0.7834	0.7531	0.2217	30.9	
16	2.537	0.3604	0.4560	1.2499	0.7939	0.7903	0.2135	28.4	
17	2.991	0.3930	0.4829	1.2825	0.7996	0.8138	0.2030	26.3	
18	3.751	0.4347	0.5172	1.3242	0.8069	0.8404	0.1920	23.2	
19	4.655	0.4634	0.5413	1.3529	0.8116	0.8561	0.1851	19.9	
20	5.241	0.4753	0.5512	1.3648	0.8136	0.8624	0.1826	18.1	
21	5.832	0.4848	0.5610	1.3743	0.8133	0.8641	0.1786	16.6	
22	6.743	0.4927	0.5730	1.3822	0.8092	0.8598	0.1715	14.6	
23	7.668	0.4882	0.5748	1.3777	0.8029	0.8494	0.1667	12.7	
24	9.205	0.4782	0.5778	1.3677	0.7898	0.8275	0.1565	10.4	
25	10.684	0.4658	0.5728	1.3553	0.7825	0.8131	0.1527	8.7	
26	12.210	0.4543	0.5692	1.3438	0.7745	0.7980	0.1479	7.4	
27	13.750	0.4447	0.5655	1.3342	0.7687	0.7864	0.1445	6.5	
28	15.241	0.4362	0.5619	1.3257	0.7639	0.7764	0.1417	5.7	
29	16.773	0.4296	0.5600	1.3191	0.7591	0.7672	0.1384	5.1	
30	18.226	0.4190	0.5515	1.3085	0.7570	0.7598	0.1394	4.6	

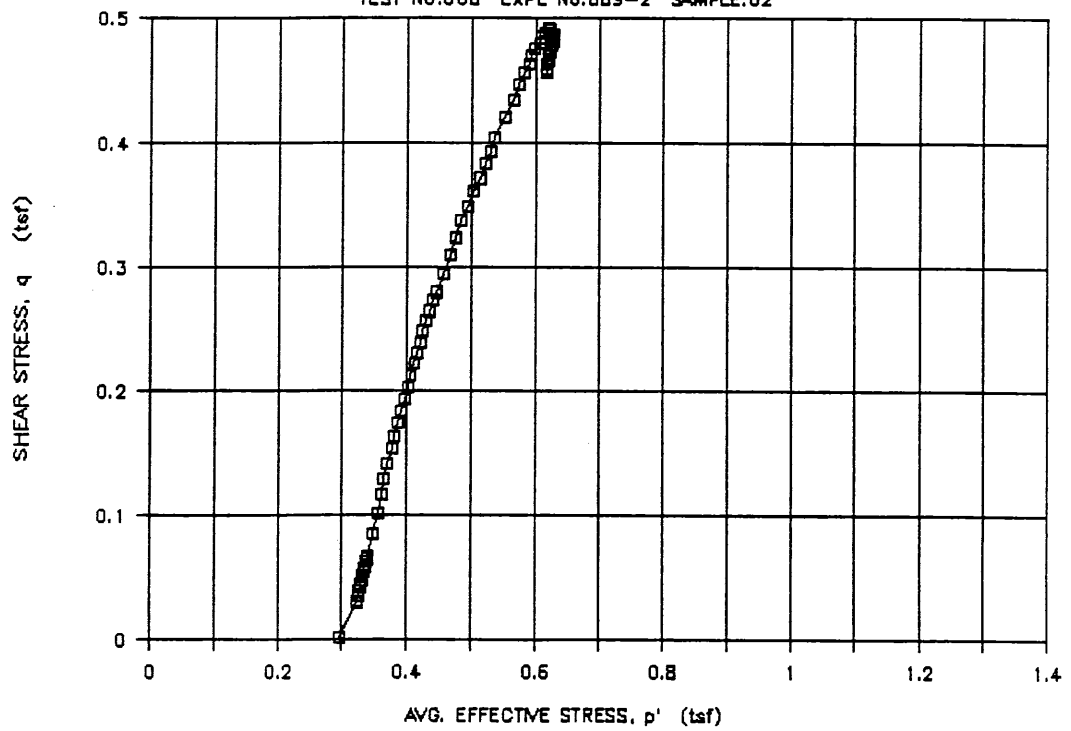
STRESS STRAIN CURVE

TEST No:UUB EXPL No:BB9-2 SAMPLE:U2



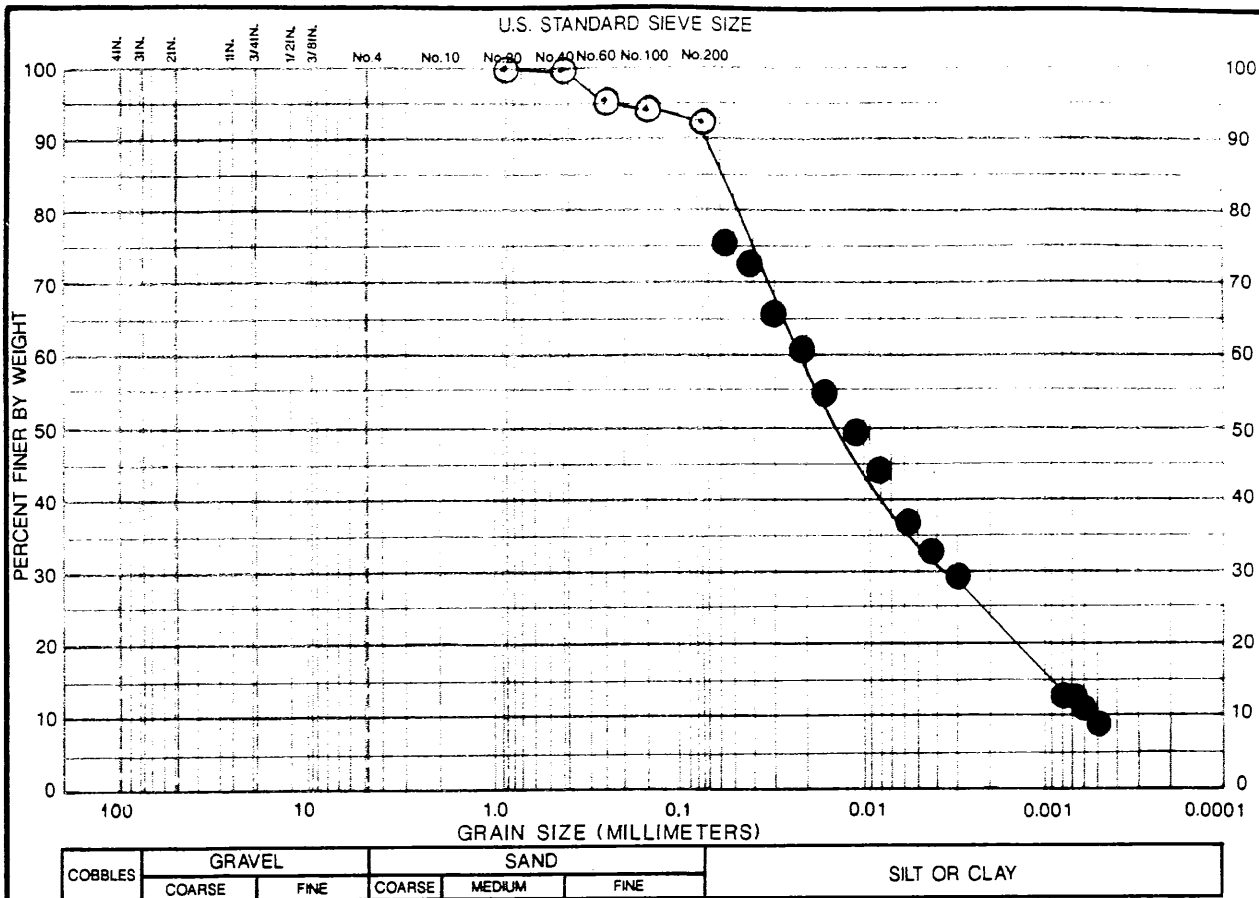
STRESS PATH

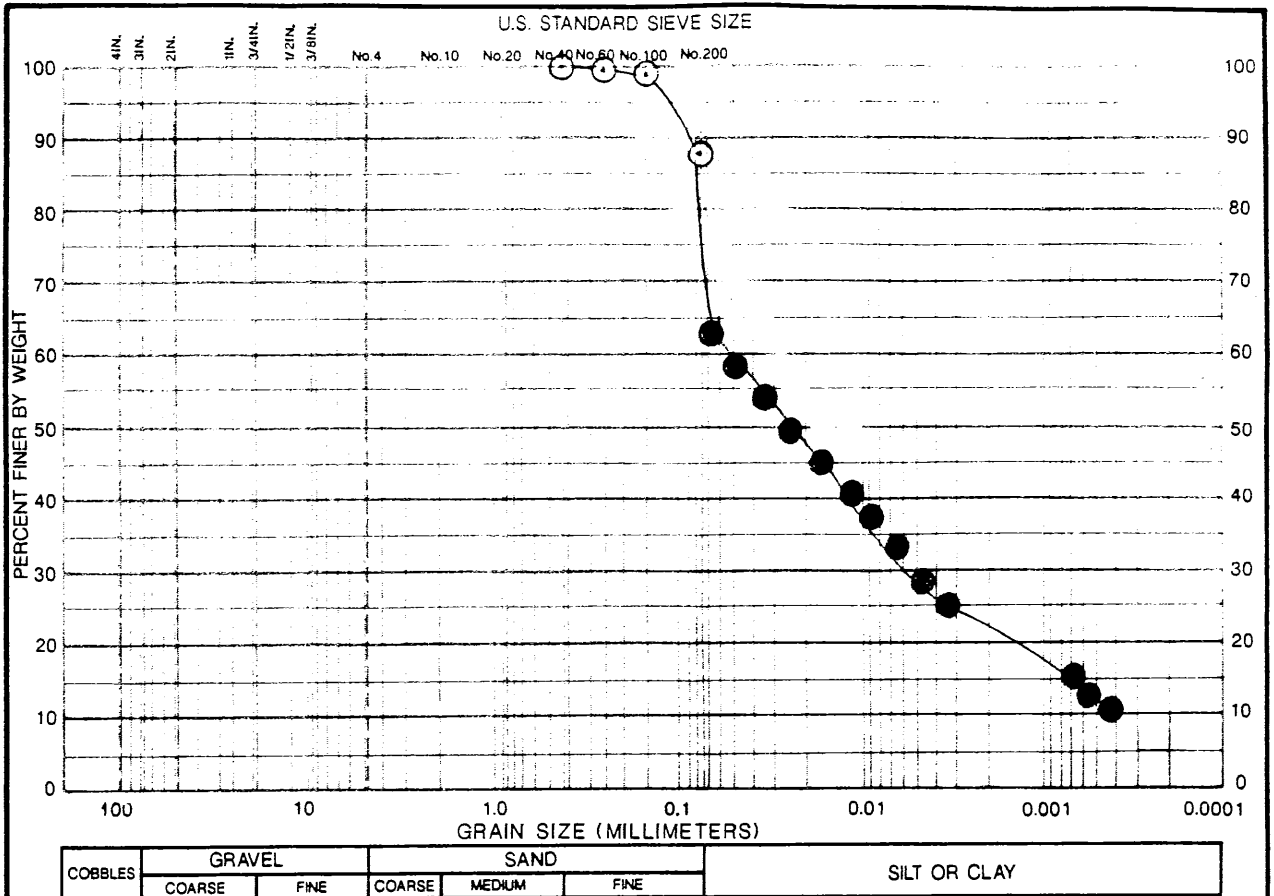
TEST No:UUB EXPL No:BB9-2 SAMPLE:U2



FILE NO.

HALEY & ALDRICH, INC.





UNIFIED SOIL CLASSIFICATION SYSTEM

SYMBOL	EXPL. NO.	SAMPLE NO.	DEPTH (feet)	SAMPLE SOURCE	PROPOSED USE	SAMPLE DESCRIPTION
⊙	B89-3	U1	22.0-24.0			Soft dark gray ORGANIC CLAY, little fine sand

SYMBOL	EXPL. NO.	SAMPLE NO.	C _u	C _c	NATURAL WATER CONTENT (%)	ATTERBERG LIMITS (%)			L O I (% by wgt.)
						W _L	W _p	I _p	
⊙	B89-3	U1			46.4	62.0	27.8	34.2	4.1
						37.4	oven dried		



Haley & Aldrich, Inc.
Consulting Geotechnical Engineers, Geologists and Hydrogeologists

ROUGHANS POINT
REVERE, MASSACHUSETTS
GRAIN SIZE DISTRIBUTION

FILE NO. 10259-01

DATE: Feb. 1990

DATE: Feb. 1990

APPENDIX D
Chain of Custody Logs



Geologists and
Hydrogeologists

58 Charles Street
Cambridge, MA 02141
617/494-1606

Letter of Transmittal

To USACE Materials Laboratory
424 Trapelo Road
Waltham, MA 02254-9149
Attention Mr. Mike Carrol

Date 4 January 1990
File Number 10250.01
Subject Roughens Point
Revere, MA

Copies	Date	Description
1 each	1/4/90	Test Pit Bag and Jar Samples
		TP 89-1 Jar Samples S1, S1A, S2, S2A, S3, S3A, S4, S4A
		Bag Sample S1
		TP 89-2 Jar Samples S1, S1A, S2, S2A, S3, S3A, S4, S4A
		Bag Sample S1
		TP 89-3 Jar Samples S1, S1A, S2, S2A, S3, S3A
		Bag Sample S1

Remarks

Samples to be delivered by Sullivan Express, courier service.

Copy to Mr. Paul Schimelfonyg (letter only)

Signed Thomas W. Beland, III

Branch Offices
Glastonbury, Connecticut
Portland, Maine
Bedford, New Hampshire

Affiliate
H & A of New York
Rochester, New York

CHAIN OF CUSTODY RECORD

PAGE 1 OF 2

H&A FILE NO. 10259.01		LABORATORY USE: Materials Laboratory		DELIVERY DATE 1/4/90									
PROJECT ROUGHAN'S POINT		ADDRESS 424 Trapolan Road, Waltham 02254		DATE FINAL REPORT DUE									
H&A CONTACT THOMAS W. PELNIK, III		CONTACT MR. MIKE CARROL 647-8792		PROJECT MANAGER'S NAME ALEC SMITH									
H&A SAMPLE NO.	LABORATORY SAMPLE NO.	SAMPLING		SAMPLE DEPTH	SAMPLE TYPE	ANALYSES					COMMENTS (Special instructions, cautions, etc.)		
		DATE	TIME			VOA	ADN	METALS	TEST/PCD	PET. ID		OTHER	NO. OF CONTAINERS
89-1 S-1		4 JAN 90	0900	0-2.5	SAND								Analyses to be assigned by USACE
89-1 S-1A			0900	0-2.5	SAND								
89-1 S-2			0905	2.5-5	0. SILT								
89-1 S-2A			0905	2.5-4	0. SILT								
89-1 S-3			0910	5-7.5	0. SILT								
89-1 S-3A			0910	5-7.5	0. SILT								
89-1 S-4			0915	7.5-10	CLAY								
89-1 S-4A			0915	7.5-10	CLAY								
89-2 S-1			1040	0-2	GRAVEL								
89-2 S-1A			1040	0-2	GRAVEL								
89-2 S-2		4 JAN 90	1045	4-5	PEAT								
I. Sampled and Relinquished by Sign: <i>William Azar</i> Print: WILLIAM AZAR Firm: SULLIVAN EXPRESS Date: 1/4/90 Time: 1430						REMARKS: (Sample storage, nonstandard sample bottles) Total 22 jars Note: ALSO 3 (three) bag samples labeled: TP89-1 S-1 Bag TP89-2 S-1 Bag TP89-3 S-1 Bag							
II. Relinquished by Sign: <i>William Azar</i> Print: WILLIAM AZAR Firm: SULLIVAN EXPRESS Date: 1/4/90 Time: 1415						VOA Vial Class Bottle Plastic Bottle Preservative Container Volume VOA Vial Class Jar Plastic Jar Preservative Container Volume							
III. Relinquished by Sign: <i>William Azar</i> Print: WILLIAM AZAR Firm: SULLIVAN EXPRESS Date: 1/4/90 Time: 1415						VOA Vial Class Jar Plastic Jar Preservative Container Volume							
IV. Relinquished by Sign: <i>William Azar</i> Print: WILLIAM AZAR Firm: SULLIVAN EXPRESS Date: 1/4/90 Time: 1415						VOA Vial Class Jar Plastic Jar Preservative Container Volume							
Evidence Samples tampered with? <input checked="" type="checkbox"/> No <input type="checkbox"/> Yes If Yes, explain in remarks.													

Note: Sample bottles supplied by lab, unless indicated.
 PRESERVATION KEY: ☒ - Sample chilled.
 B - Filtered. C - Acidified with ☐
 D - NaOH. E - NaThiosulfate F - Other



Consultants:
Geotechnical Engineers,
Geologists and
Hydrogeologists

58 Charles Street
Cambridge, MA 02141
(617) 494-1800

Letter of Transmittal

To	USACE Materials Laboratory	Date	26 January 1990
	424 Topelo Road	File Number	10259.01
	Waltham, MA 02254-9149	Subject	Roughans Point
Attention	Mr. Mike Carroll		Revere, MA

Copies	Date	Description
1	1/6/90	Bag Sample S-1 from test pit TP89-5, depth 0-3 ft.

Remarks

Hand delivered

PLEASE NOTE:

BAG SAMPLE S1 FROM TEST PIT TP89-4
WAS PICKED UP AT THE SITE BY USACE
PERSONNEL DURING VISIT ON
1-5-90. TWP 2-27-90

Copy to Mr. Paul Schimelfenig (letter only)

Thomas W. Pollock, IV

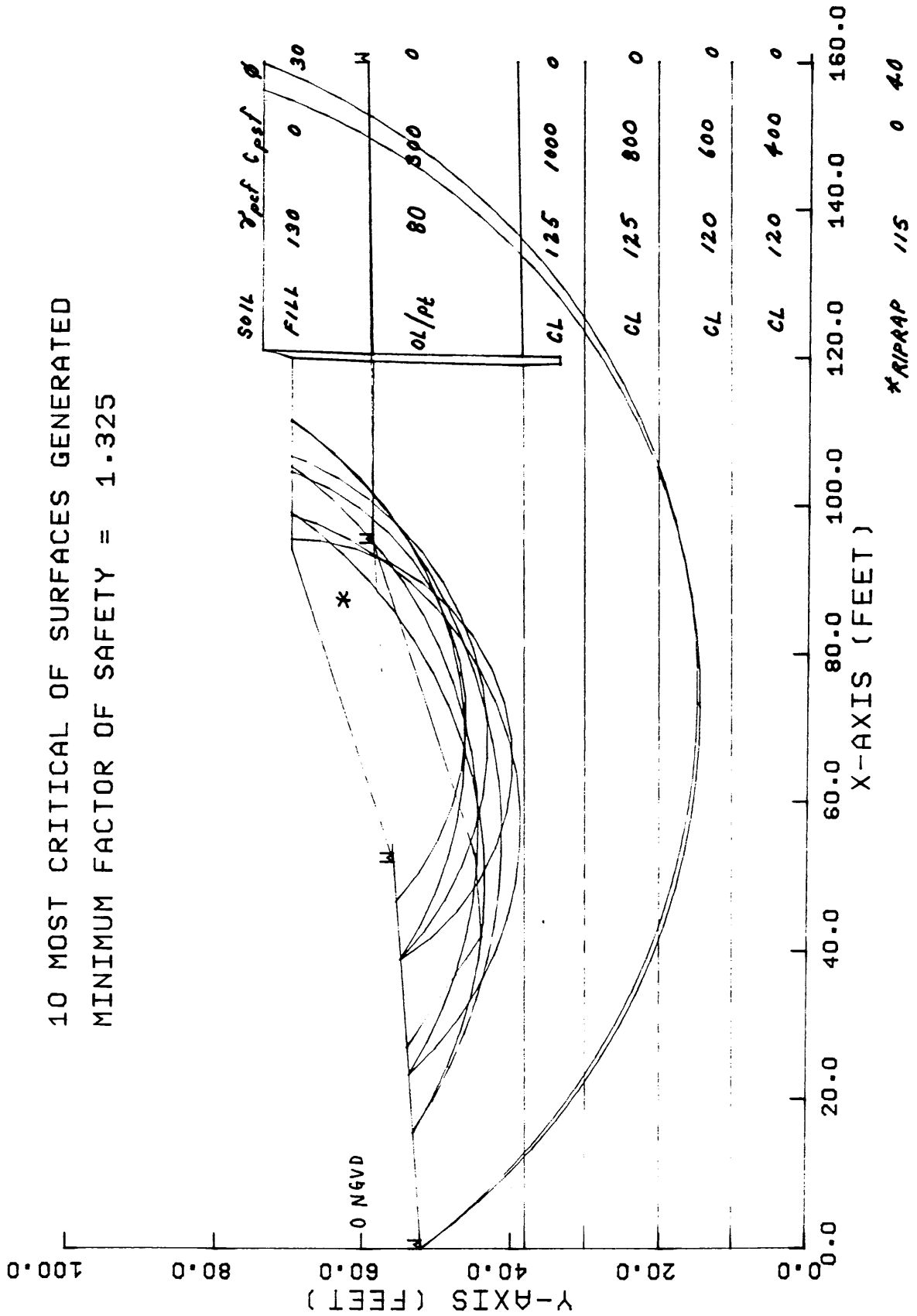
signed

Branch Offices
Glastonbury, Connecticut
Portland, Maine
Bedford, New Hampshire
Affiliate
Hickory, New York
Archery, New York

FILE NO 10259.01

SECTION AT B89-4 10259

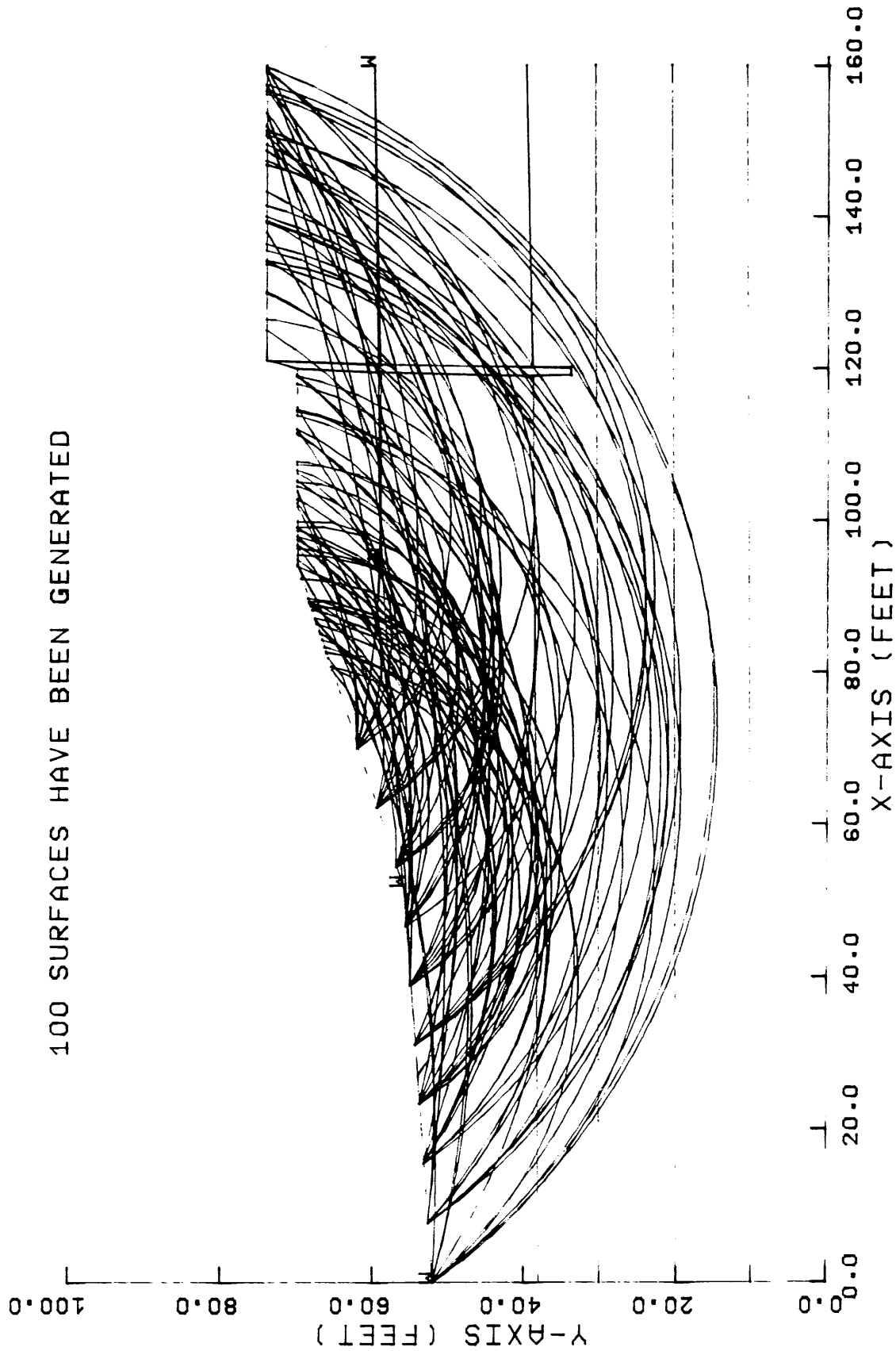
10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 1.325



FILE NO 10259.01

SECTION AT B89-4 10259

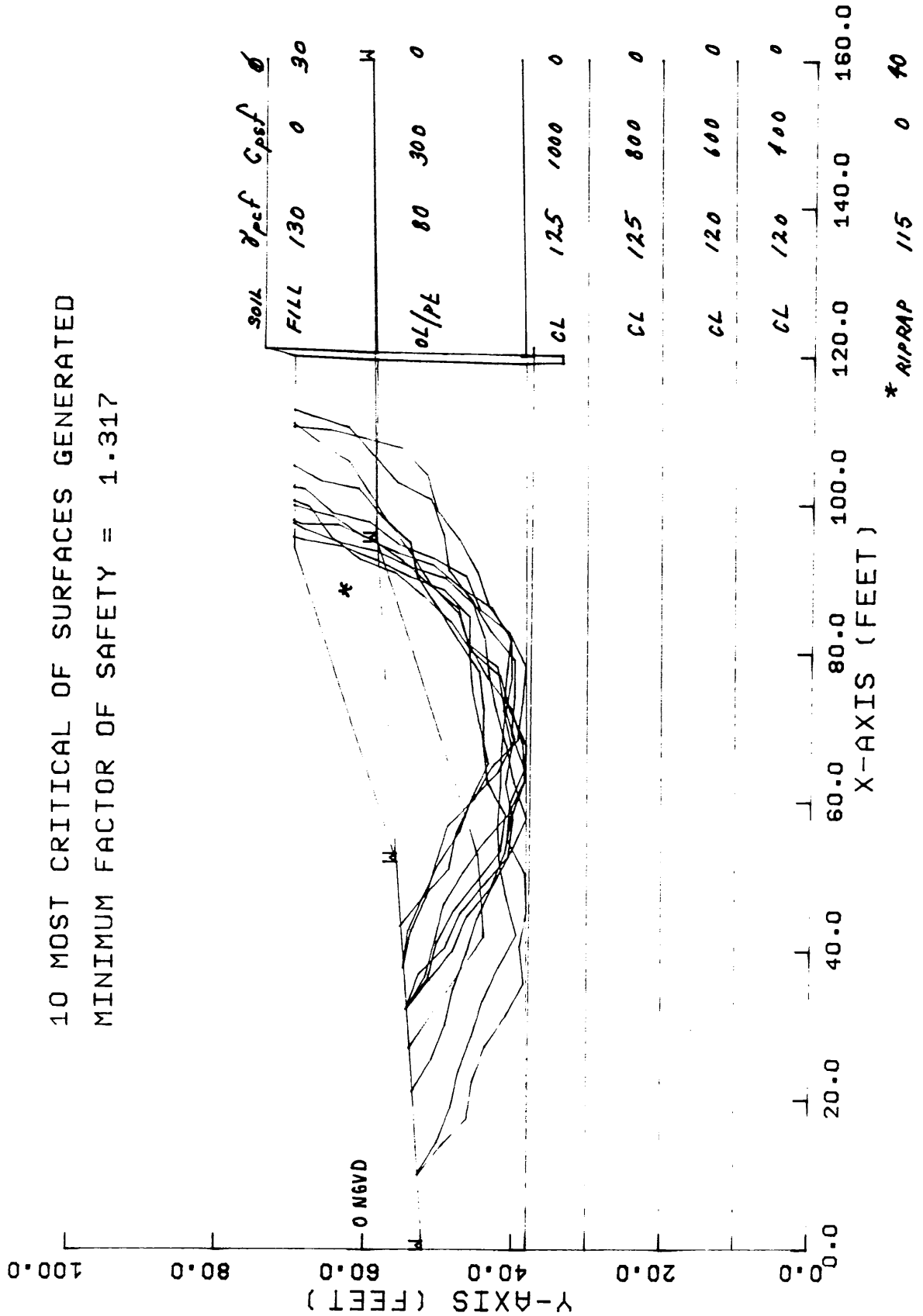
100 SURFACES HAVE BEEN GENERATED



FILE NO 10259.01

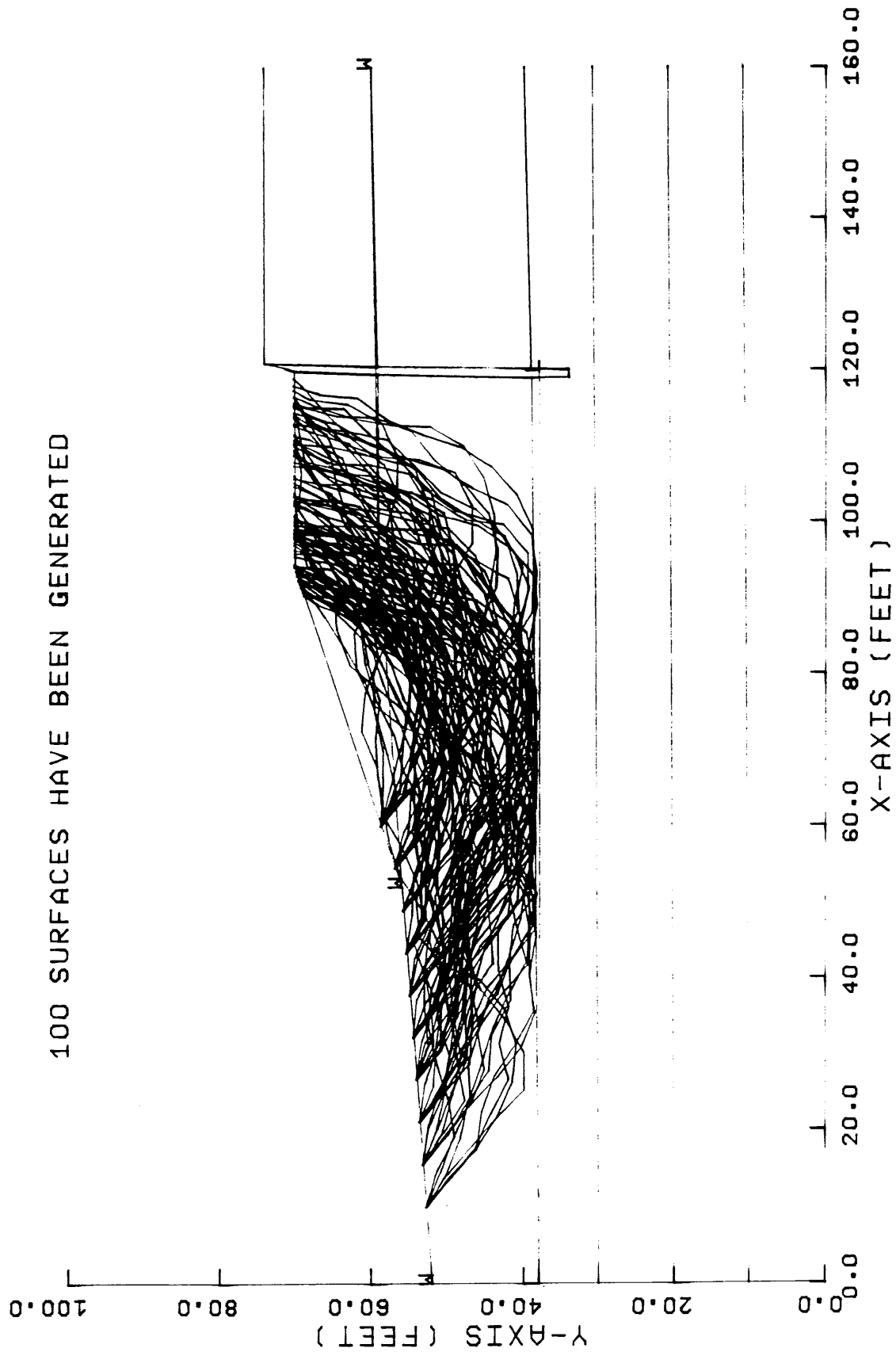
SECTION AT B89-4 10259

10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 1.317



FILE NO. 10259.01

SECTION AT B89-4 10259

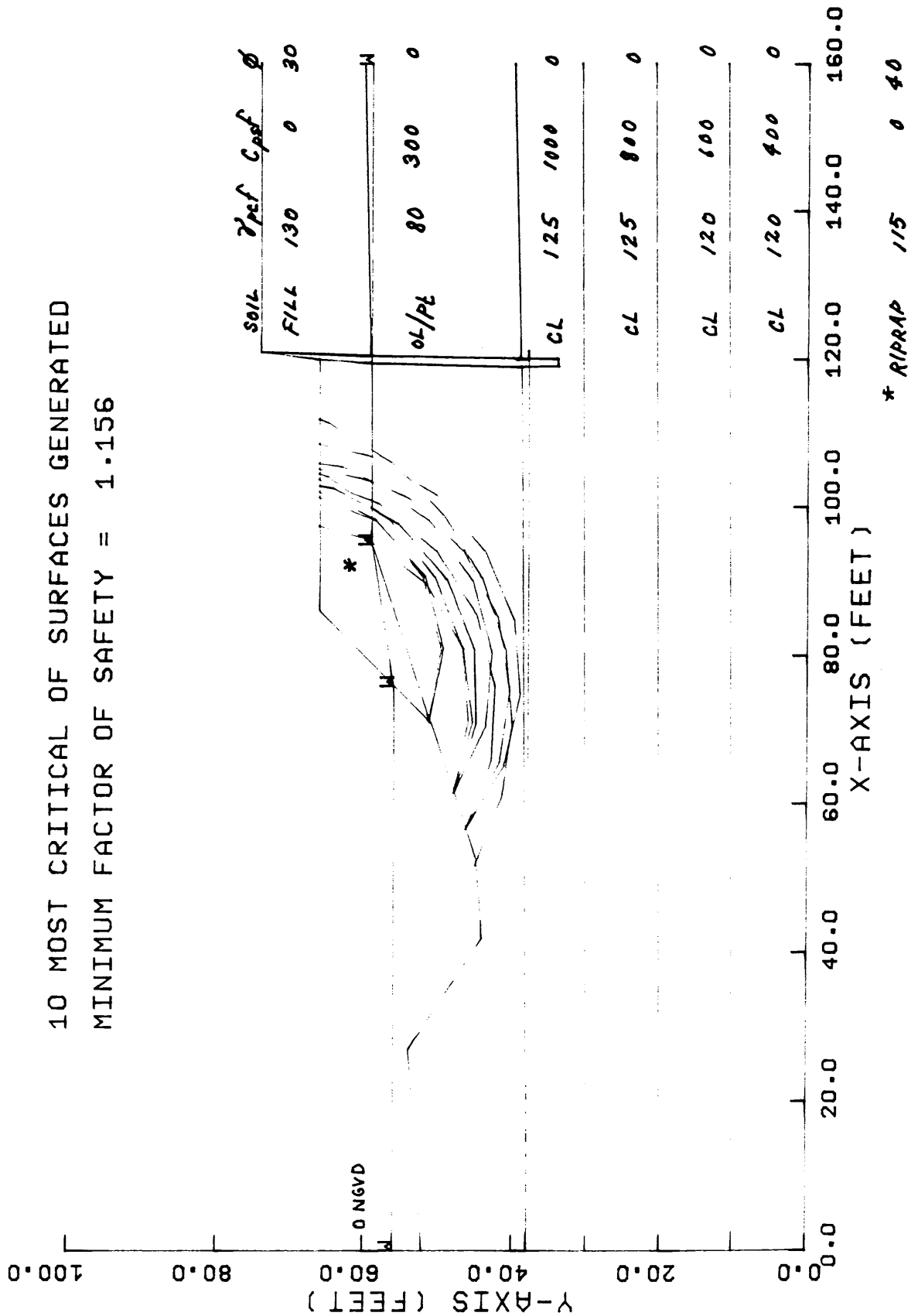


FILE NO 10259.01

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

10 MOST CRITICAL OF SURFACES GENERATED

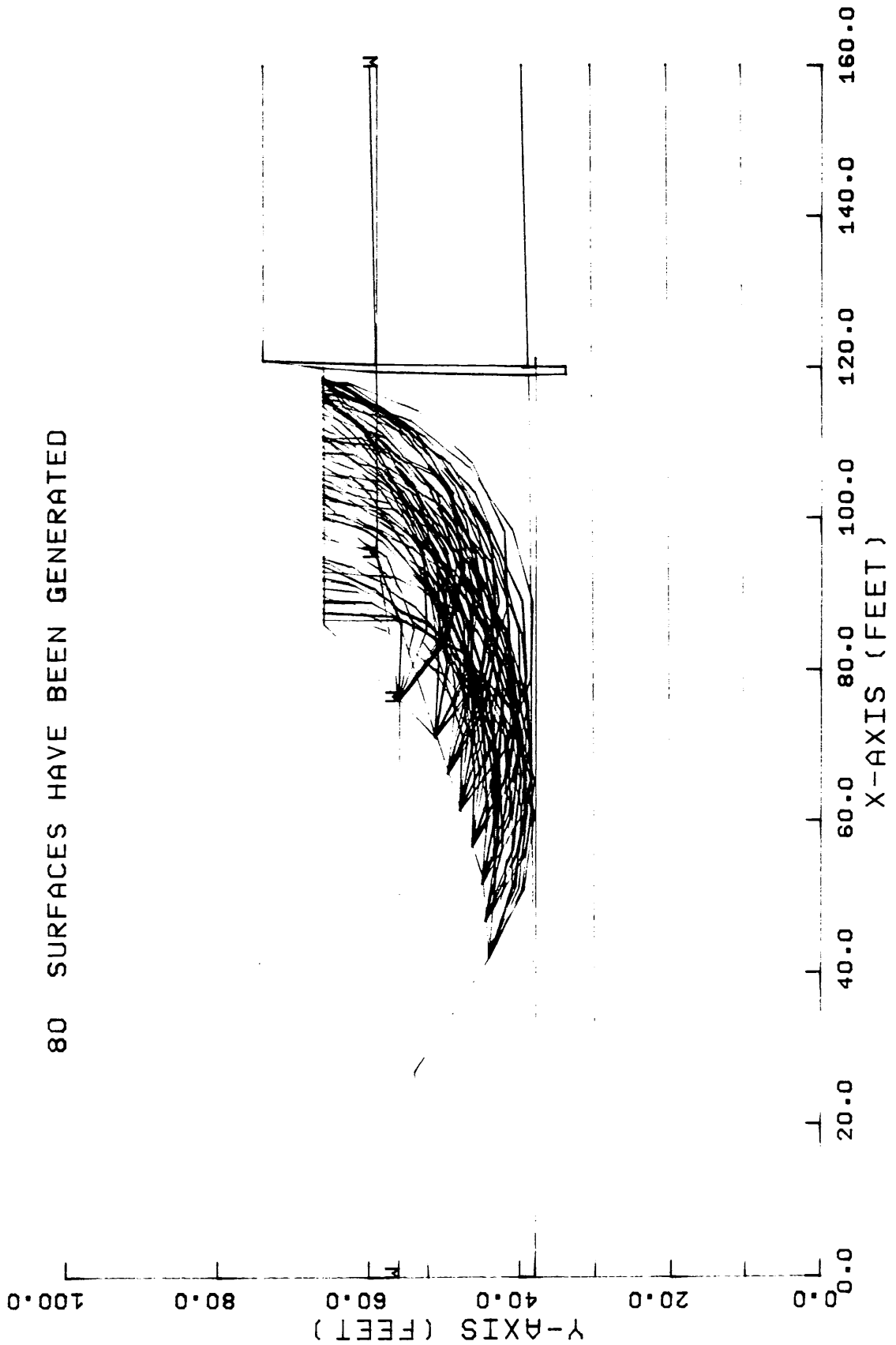
MINIMUM FACTOR OF SAFETY = 1.156



FILE NO 10259.01

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

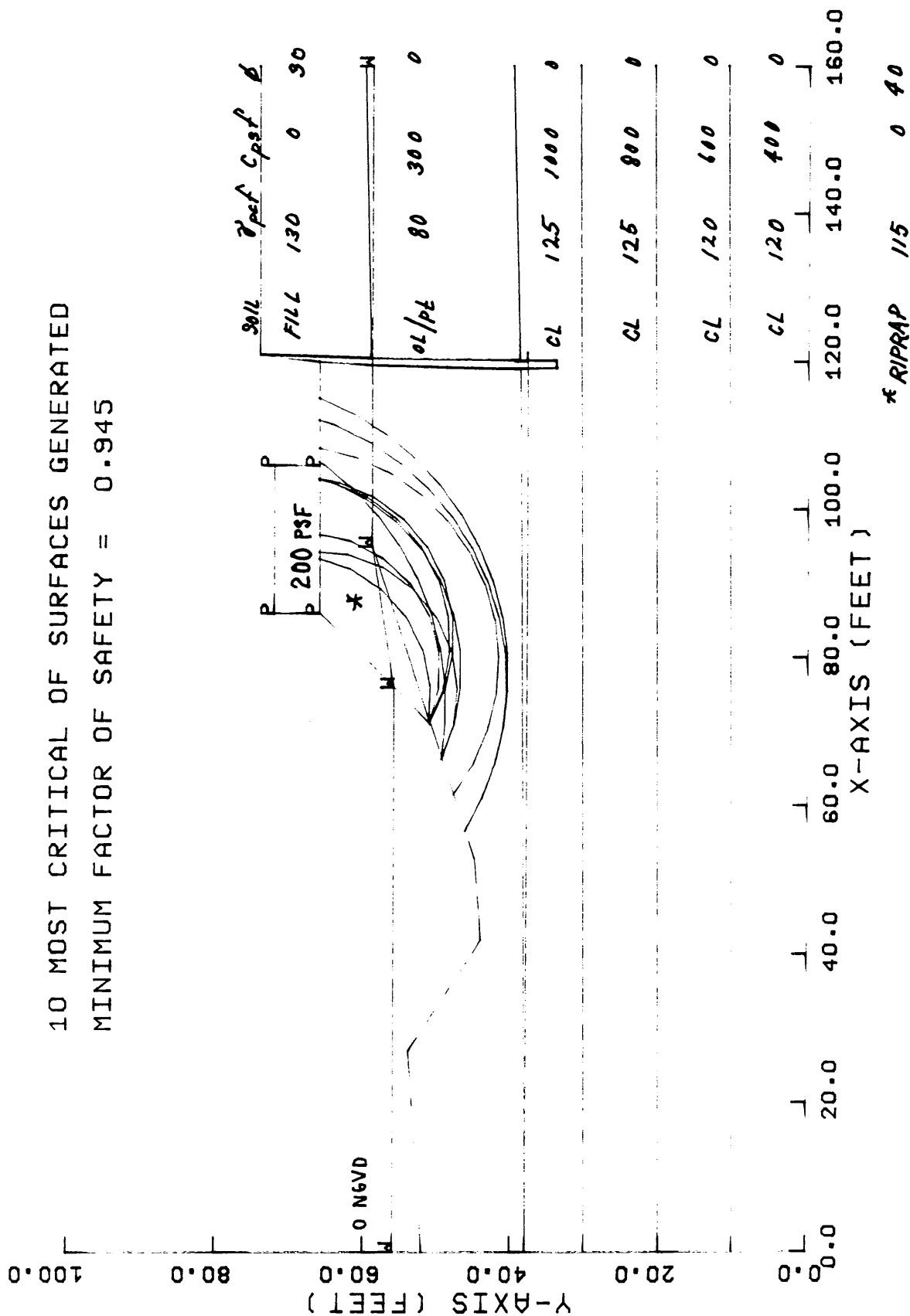
80 SURFACES HAVE BEEN GENERATED



SECTION AT B89-4, CONSTRUCTION OF
WORKING BERM 10259

10 MOST CRITICAL OF SURFACES GENERATED

MINIMUM FACTOR OF SAFETY = 0.945

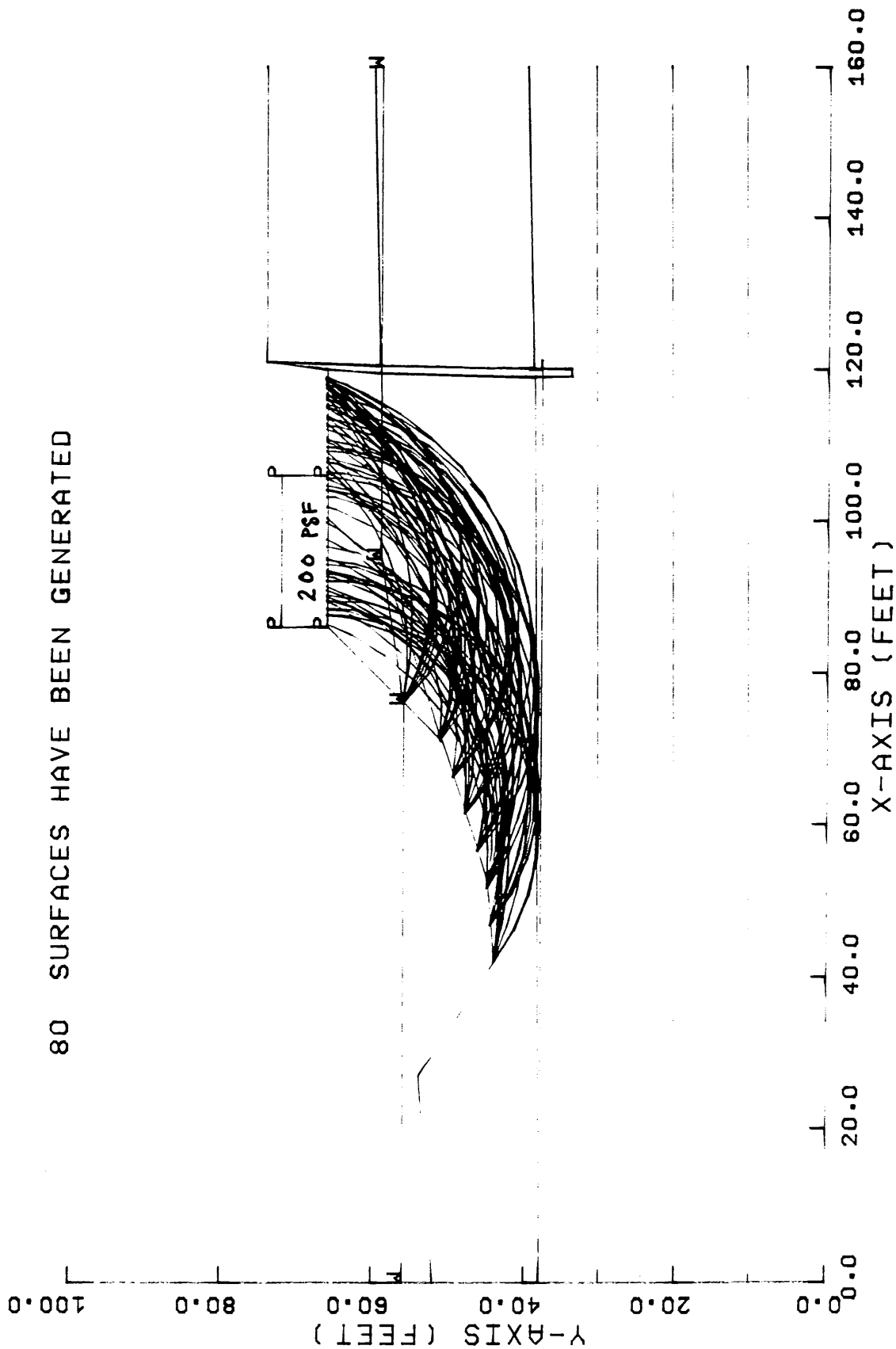


FIGURE

FILE NO 10269.01

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

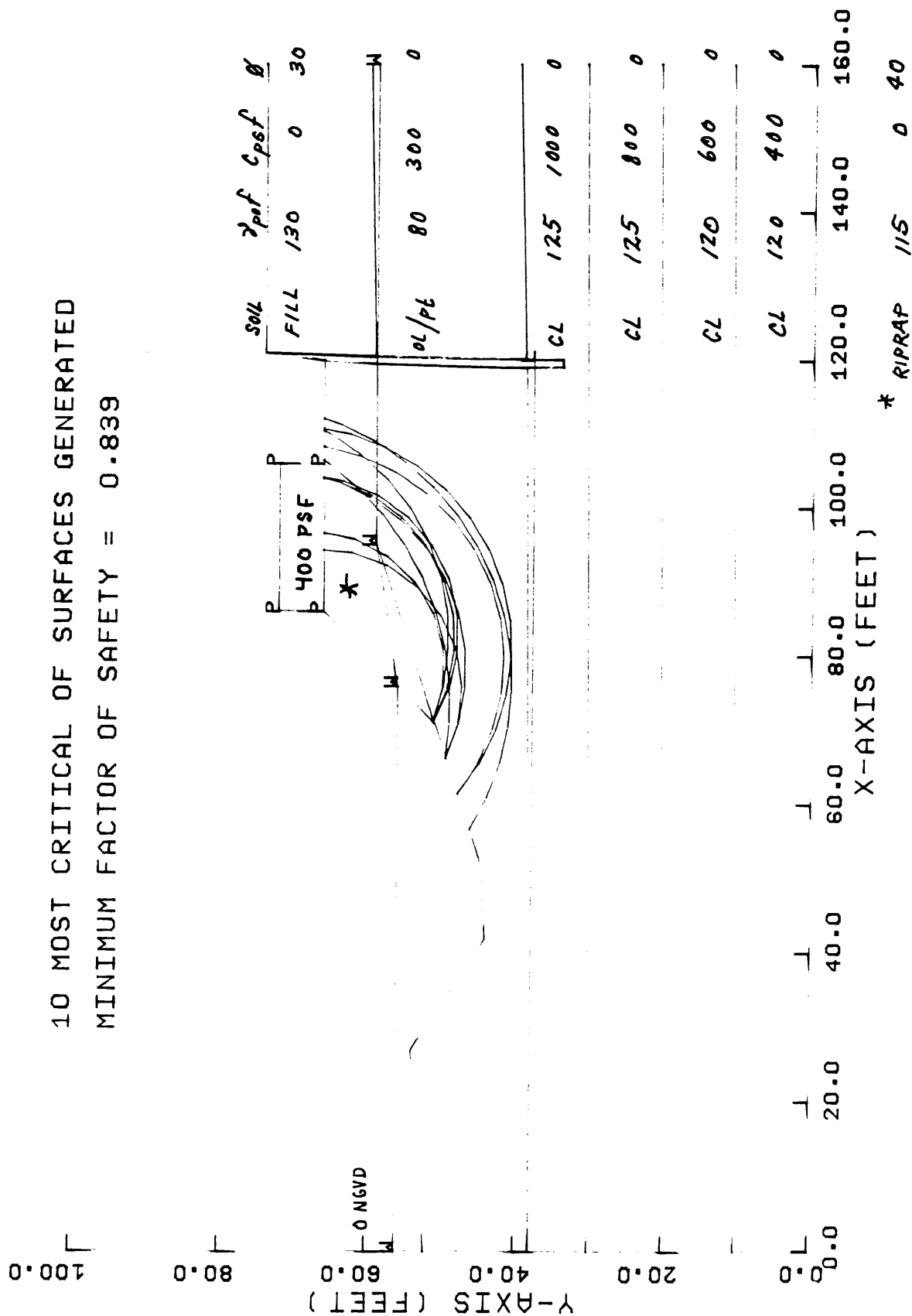
80 SURFACES HAVE BEEN GENERATED



SECTION AT B89-4, CONSTRUCTION OF
WORKING BERM 10259

10 MOST CRITICAL OF SURFACES GENERATED

MINIMUM FACTOR OF SAFETY = 0.839



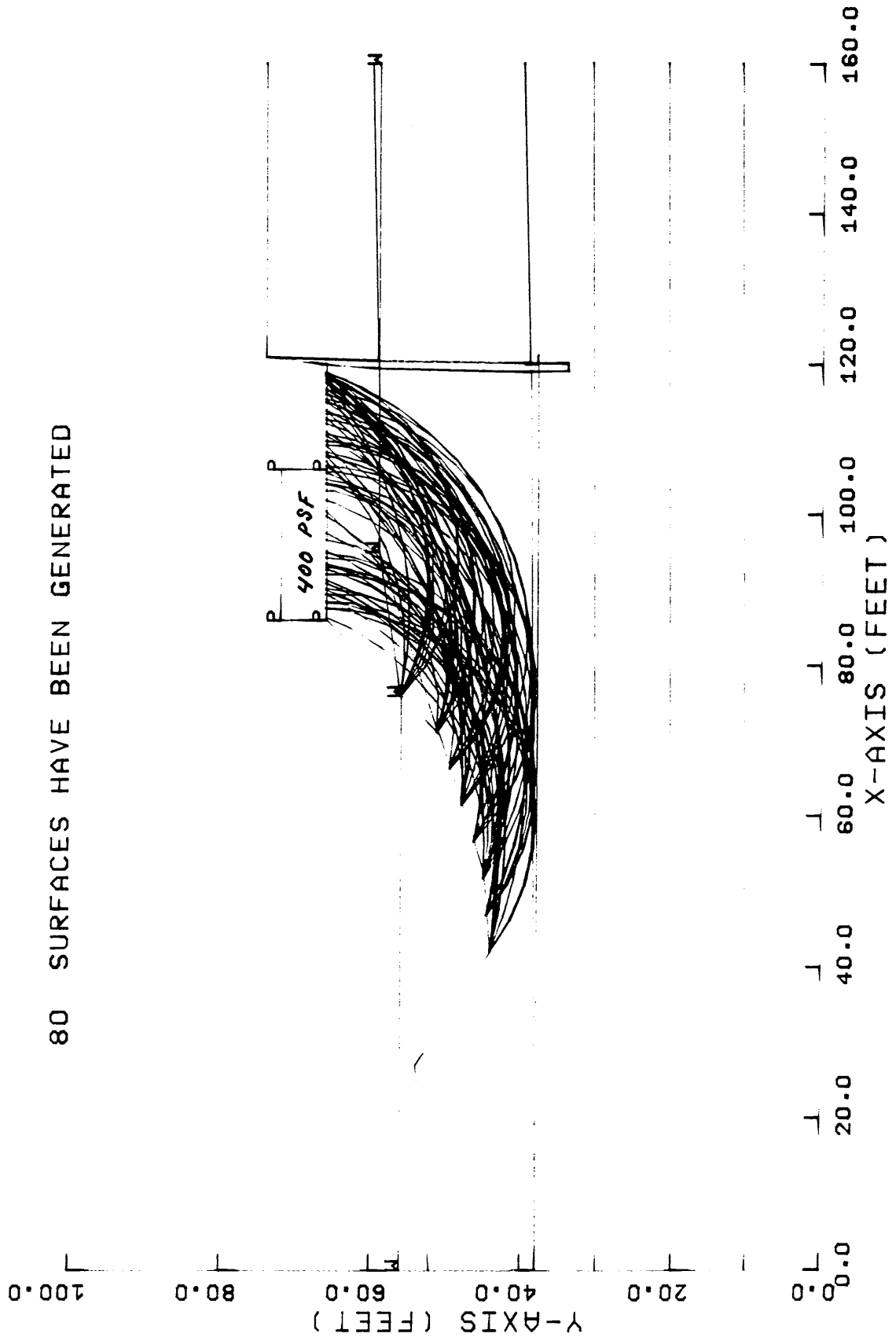
HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

FIGURE

FILE NO. 10259.01

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

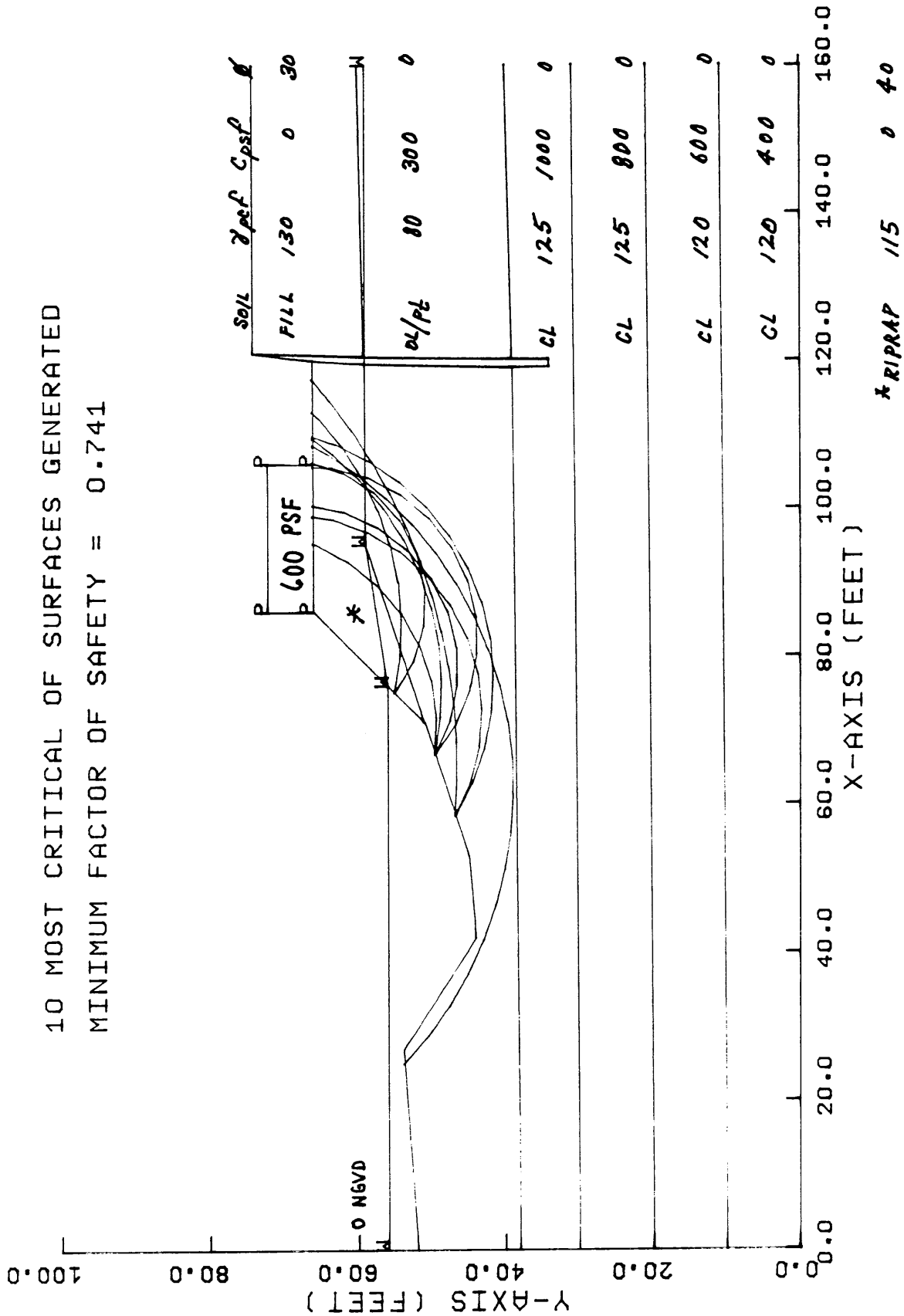
80 SURFACES HAVE BEEN GENERATED



FILE NO 10259.01

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

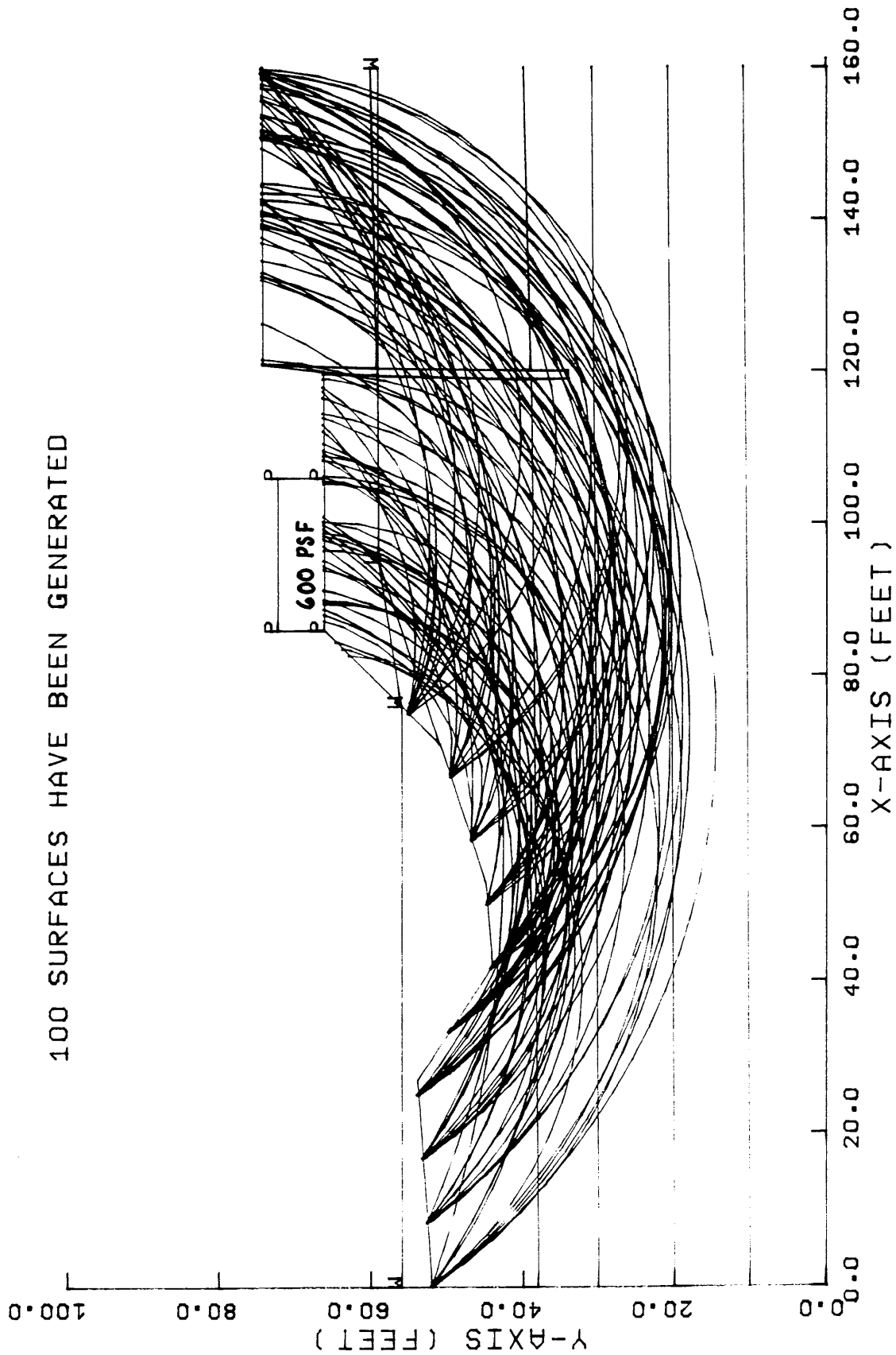
10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 0.741



FILE NO. 10259.01

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

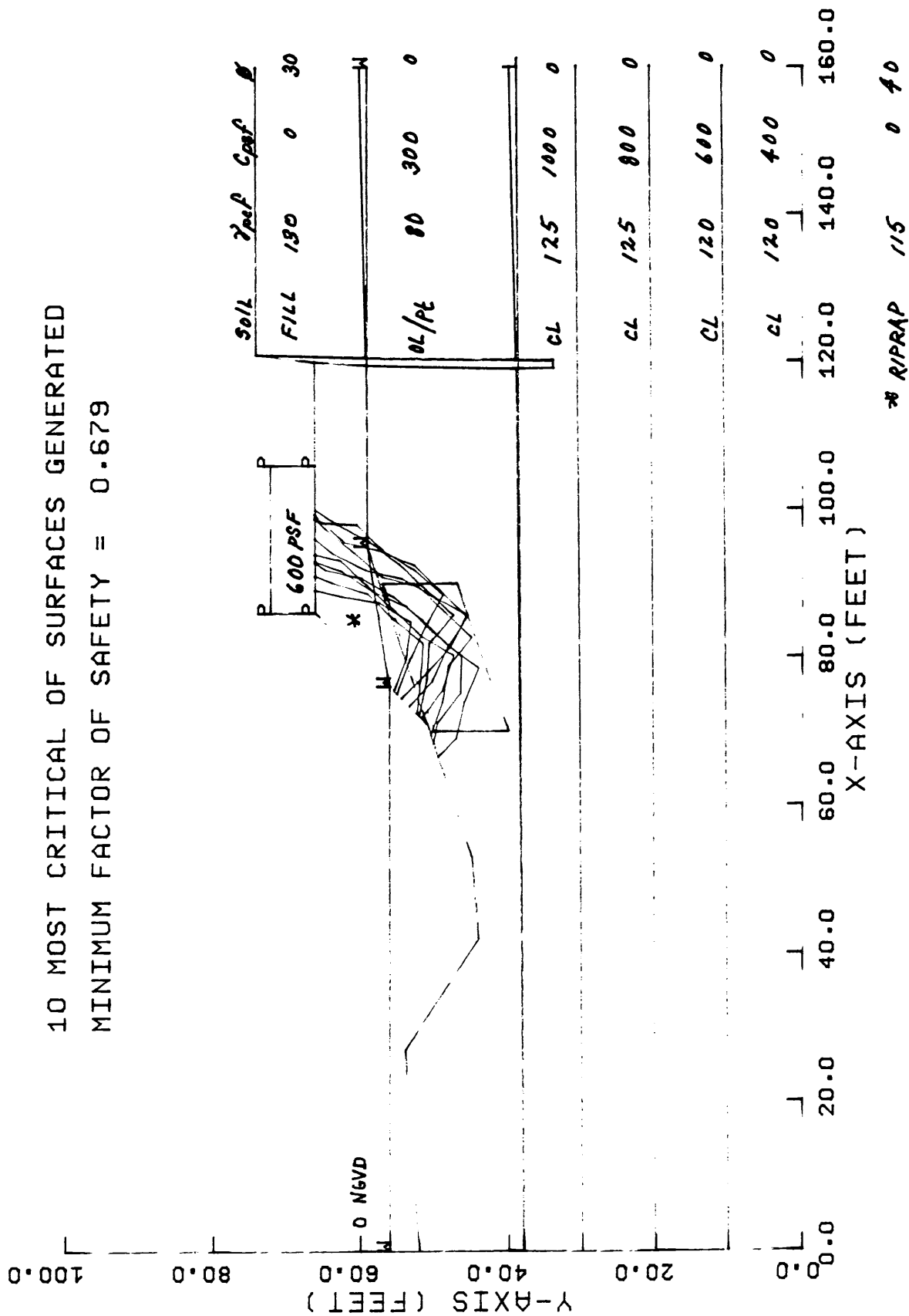
100 SURFACES HAVE BEEN GENERATED



FILE NO 10259.01

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

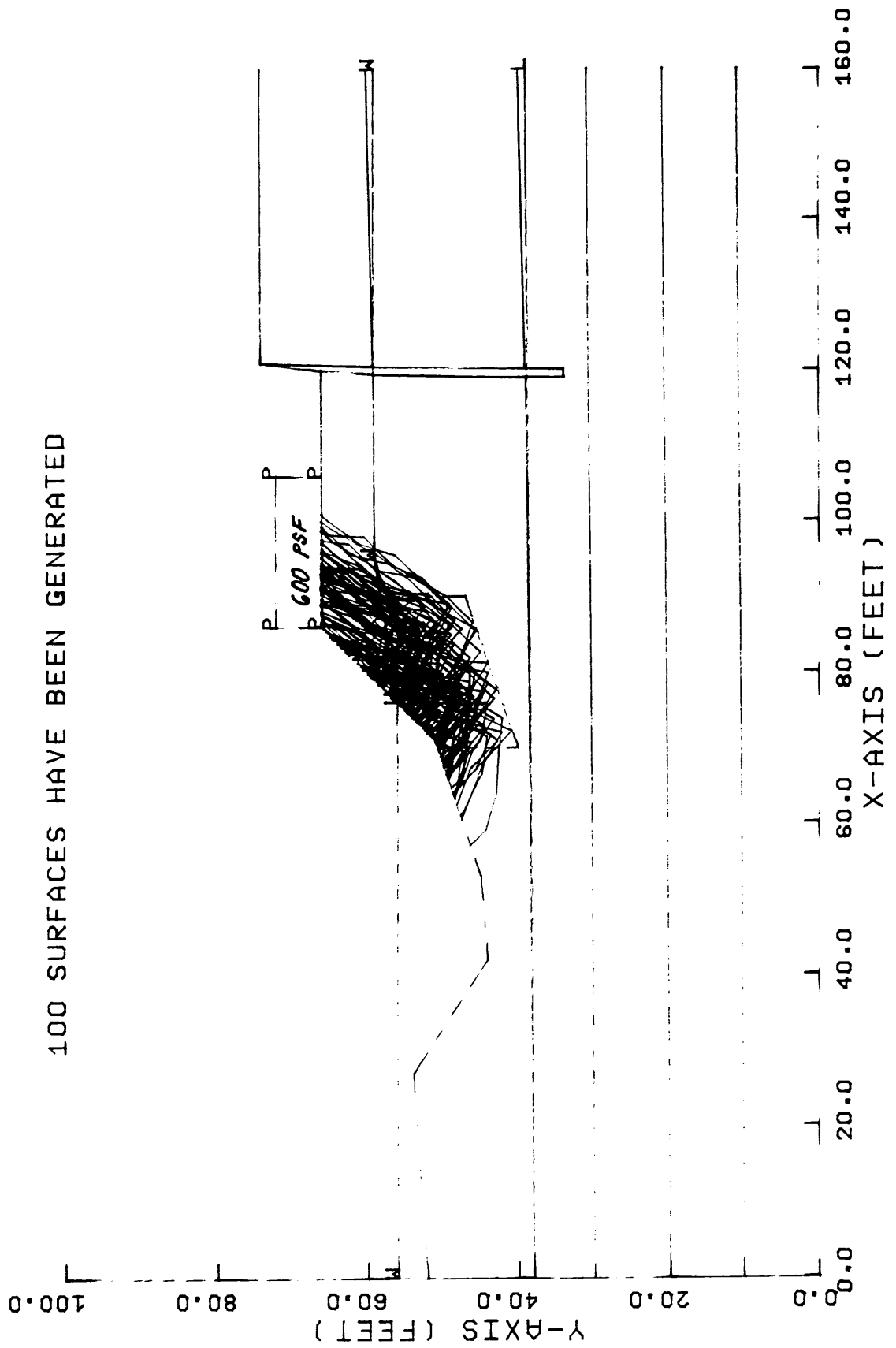
10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 0.679



FILE NO 10259.01

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

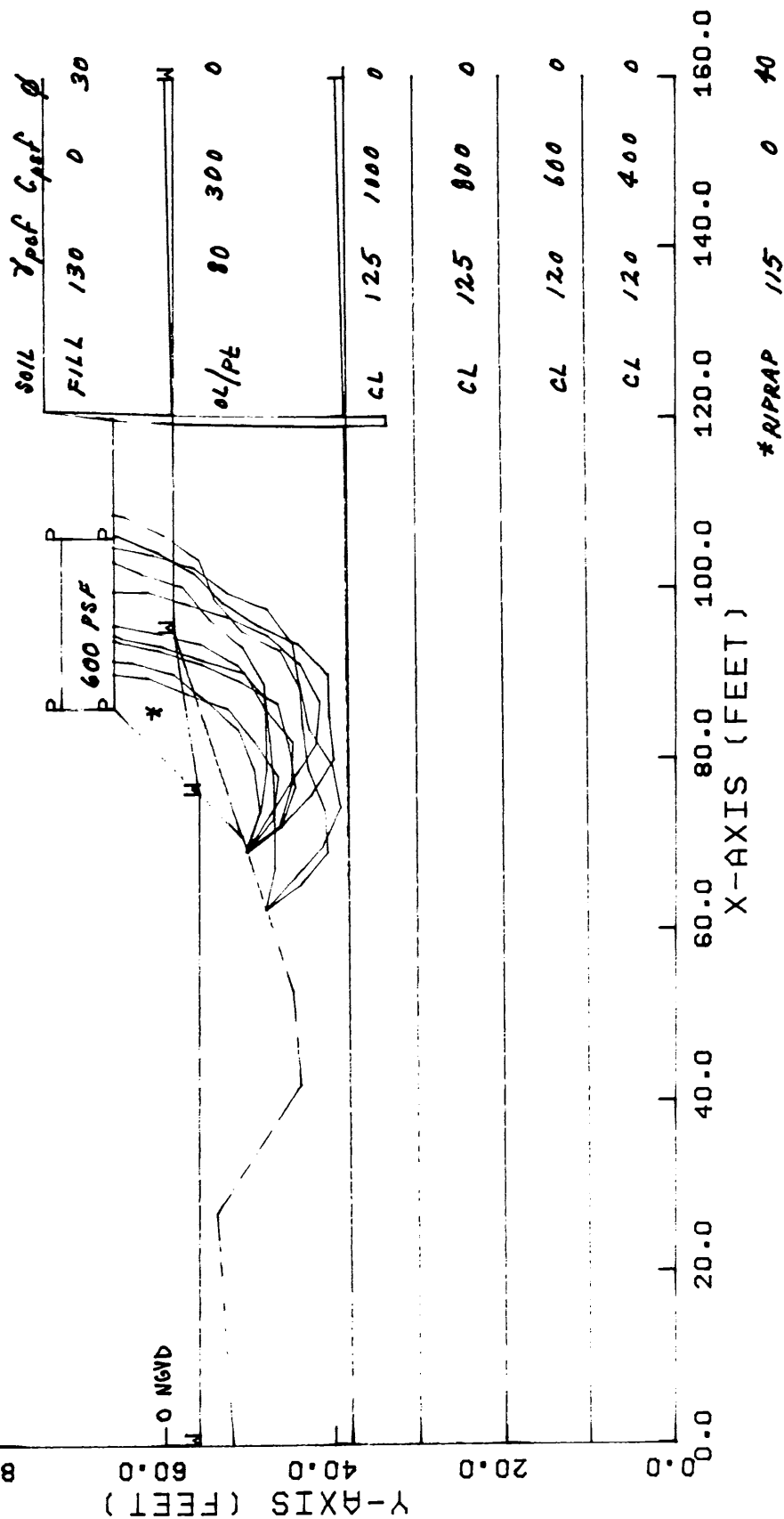
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FILE NO 10259.01

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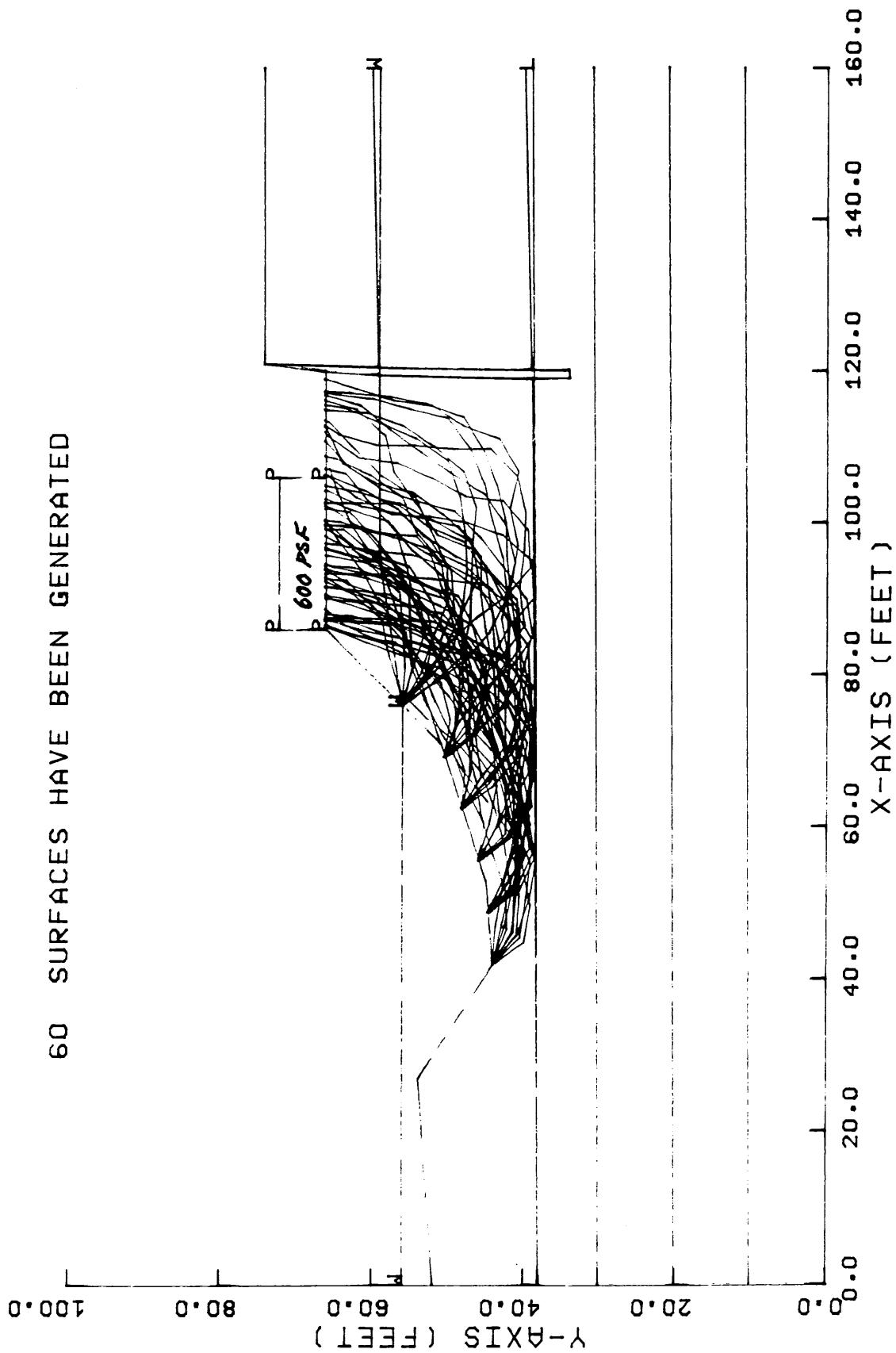
10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 0.678



FILE NO. 10259.01

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

60 SURFACES HAVE BEEN GENERATED

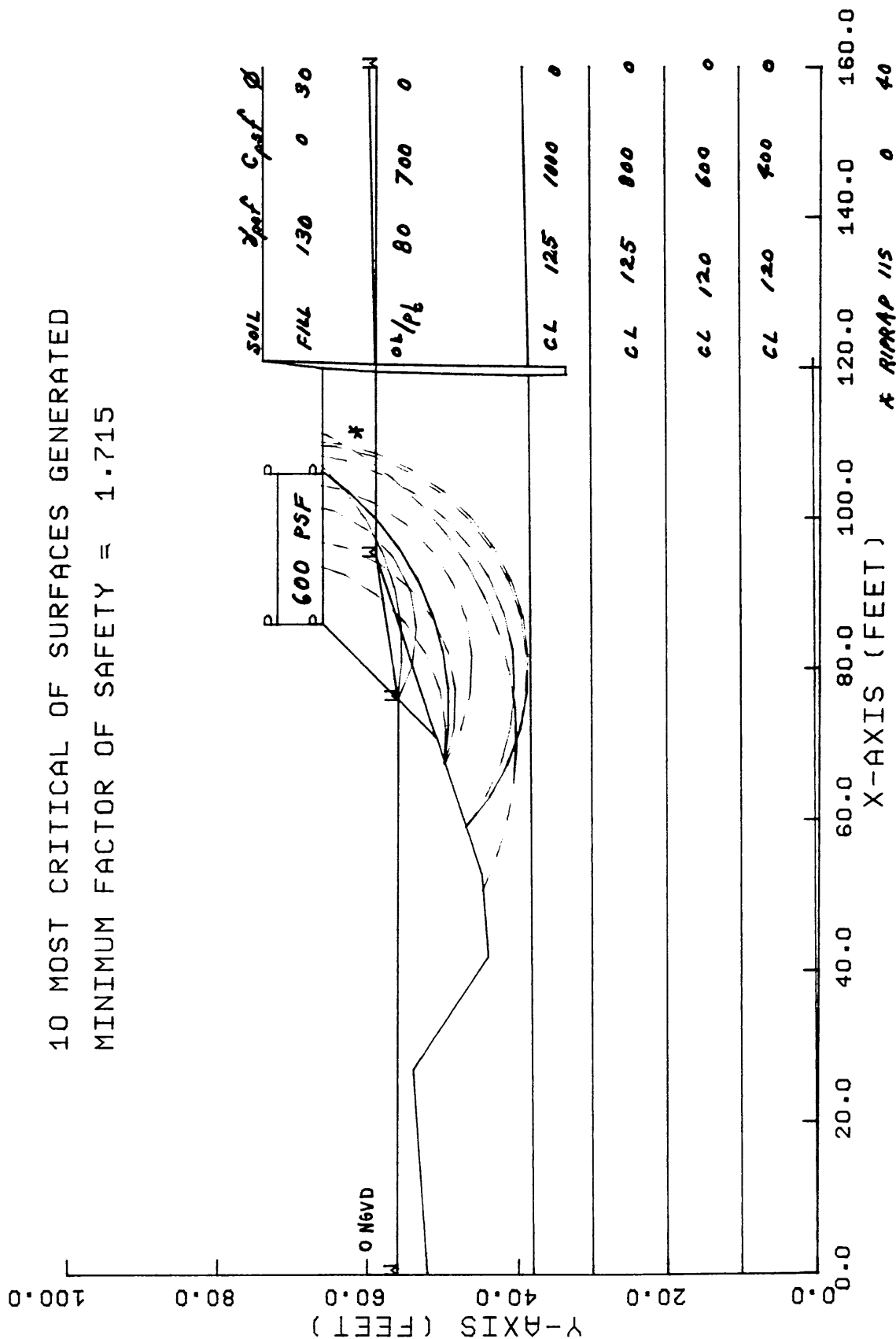


FILE NO 10259.01

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

10 MOST CRITICAL OF SURFACES GENERATED

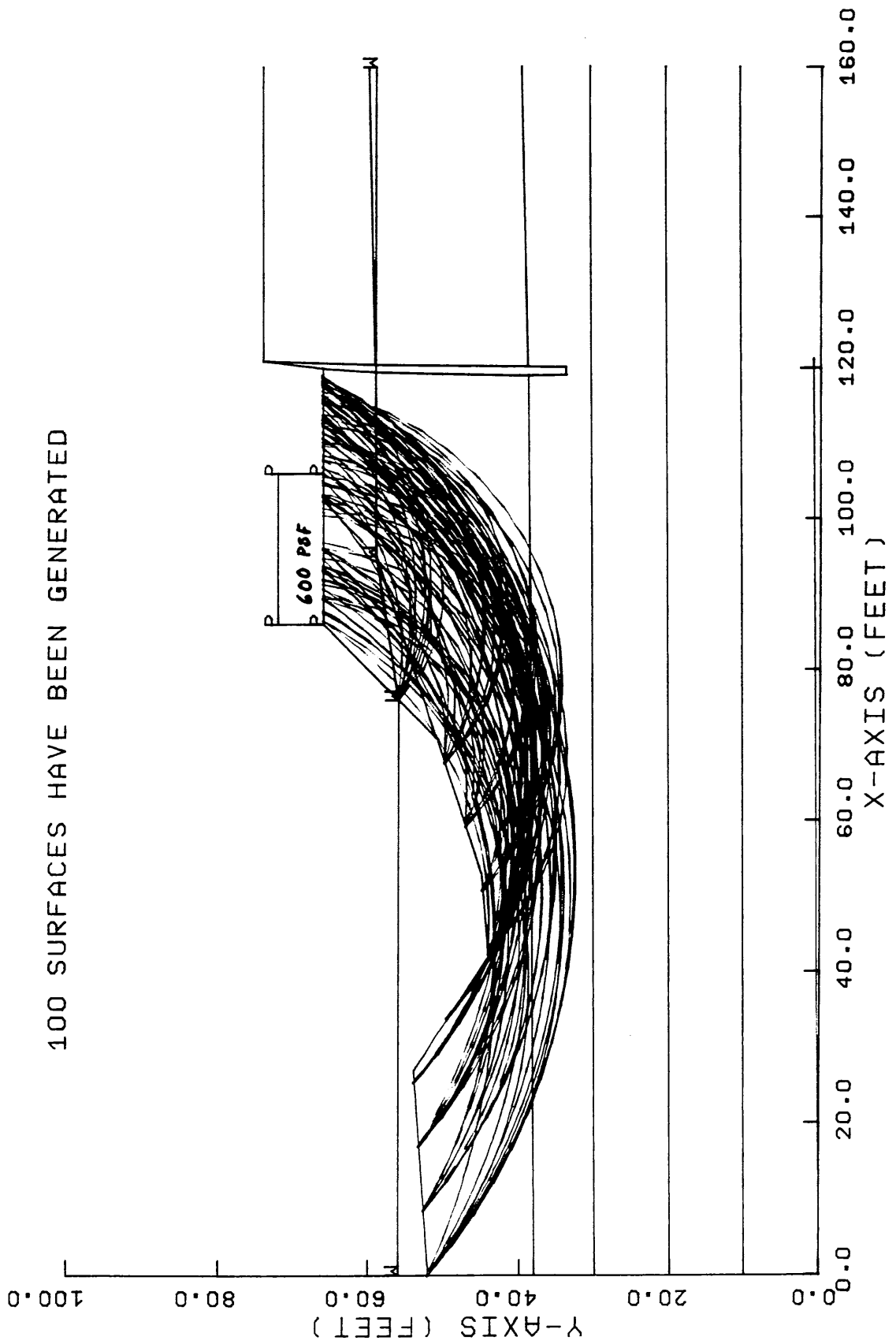
MINIMUM FACTOR OF SAFETY = 1.715



FILE NO

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

100 SURFACES HAVE BEEN GENERATED

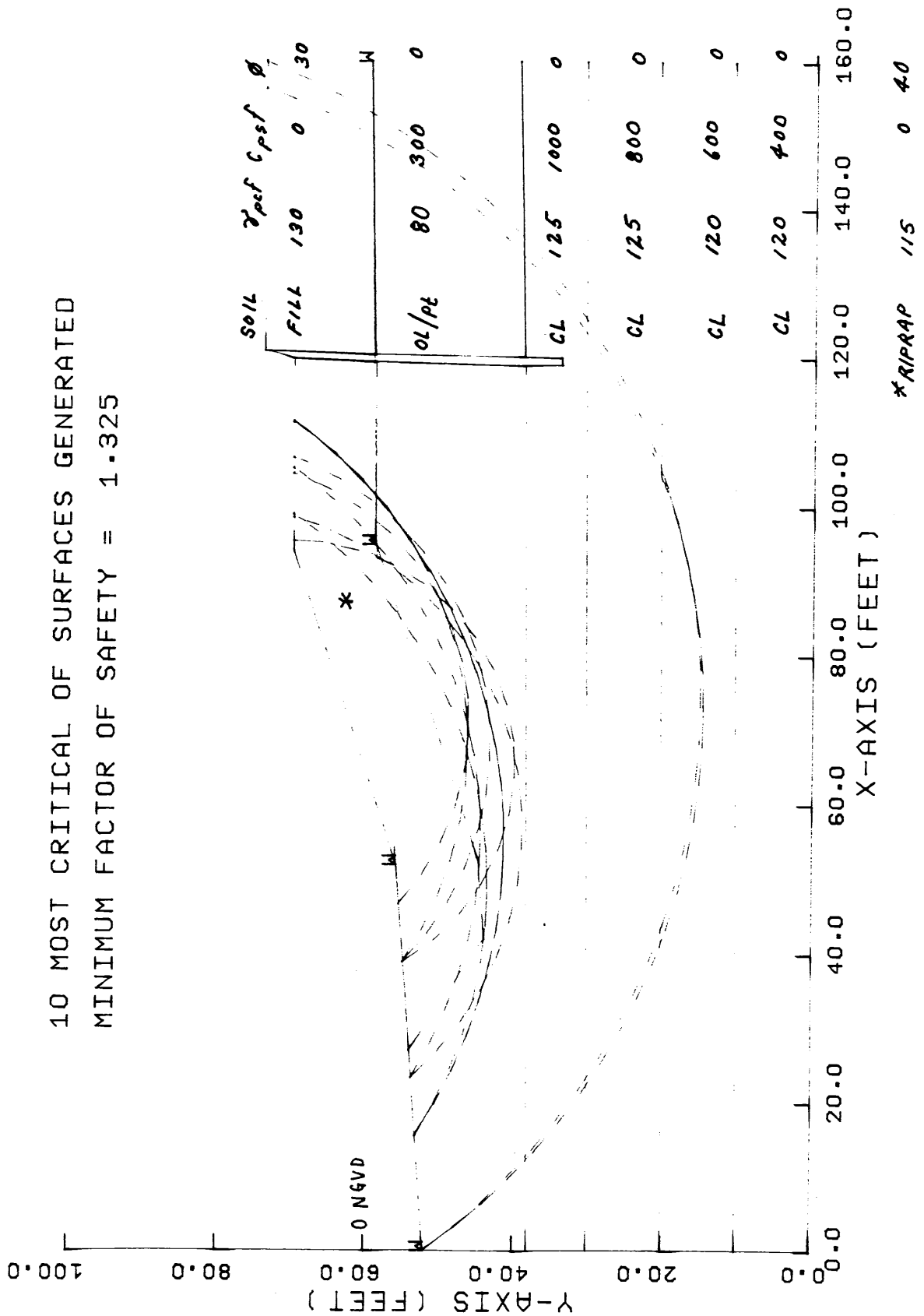


APPENDIX E
Plotted Results of Stability Analyses

FILE NO 10259.01

SECTION AT B89-4 10259

10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 1.325



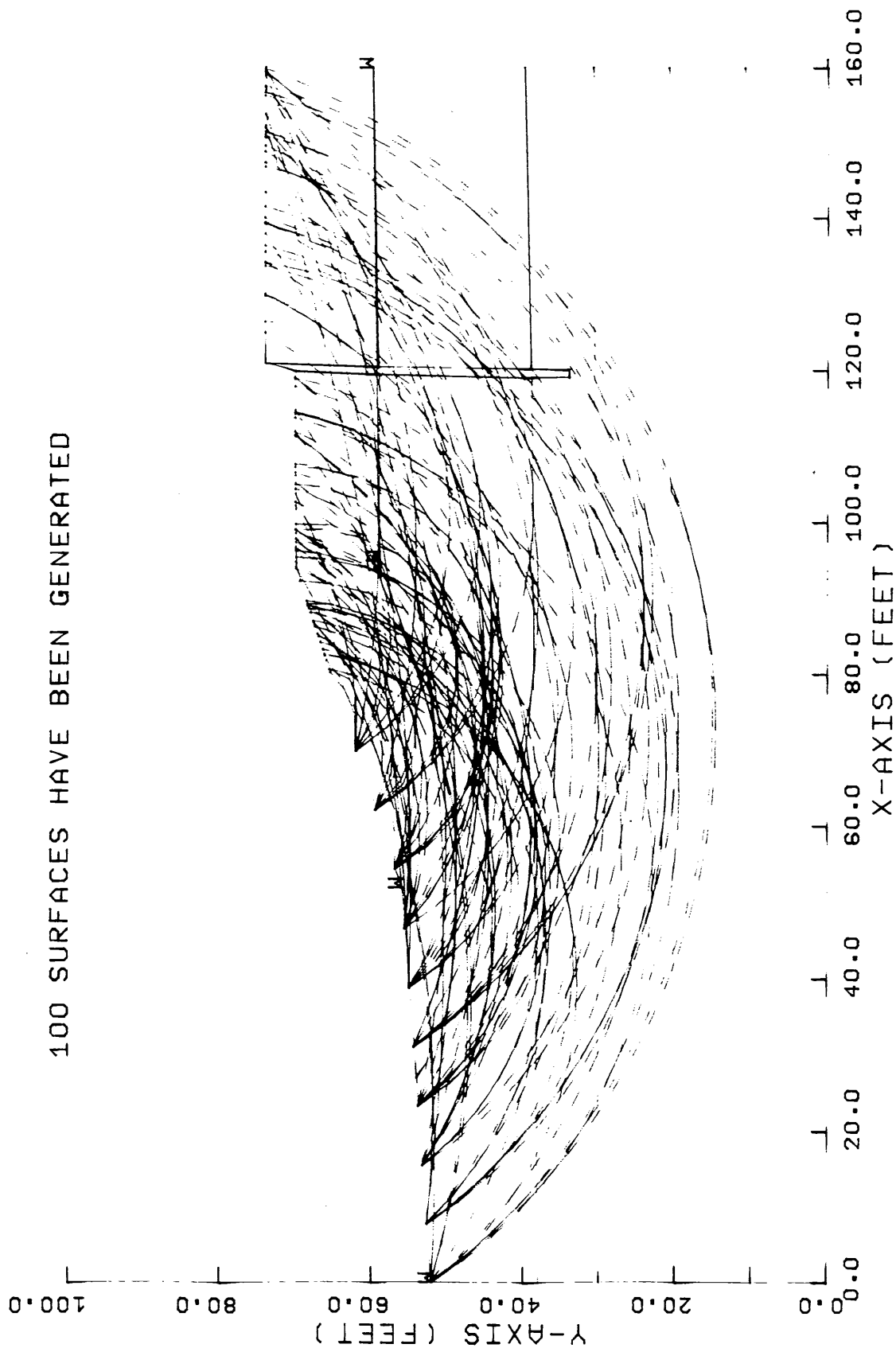
HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

FIGURE

FILE NO 10259-01

SECTION AT B89-4 10259

100 SURFACES HAVE BEEN GENERATED

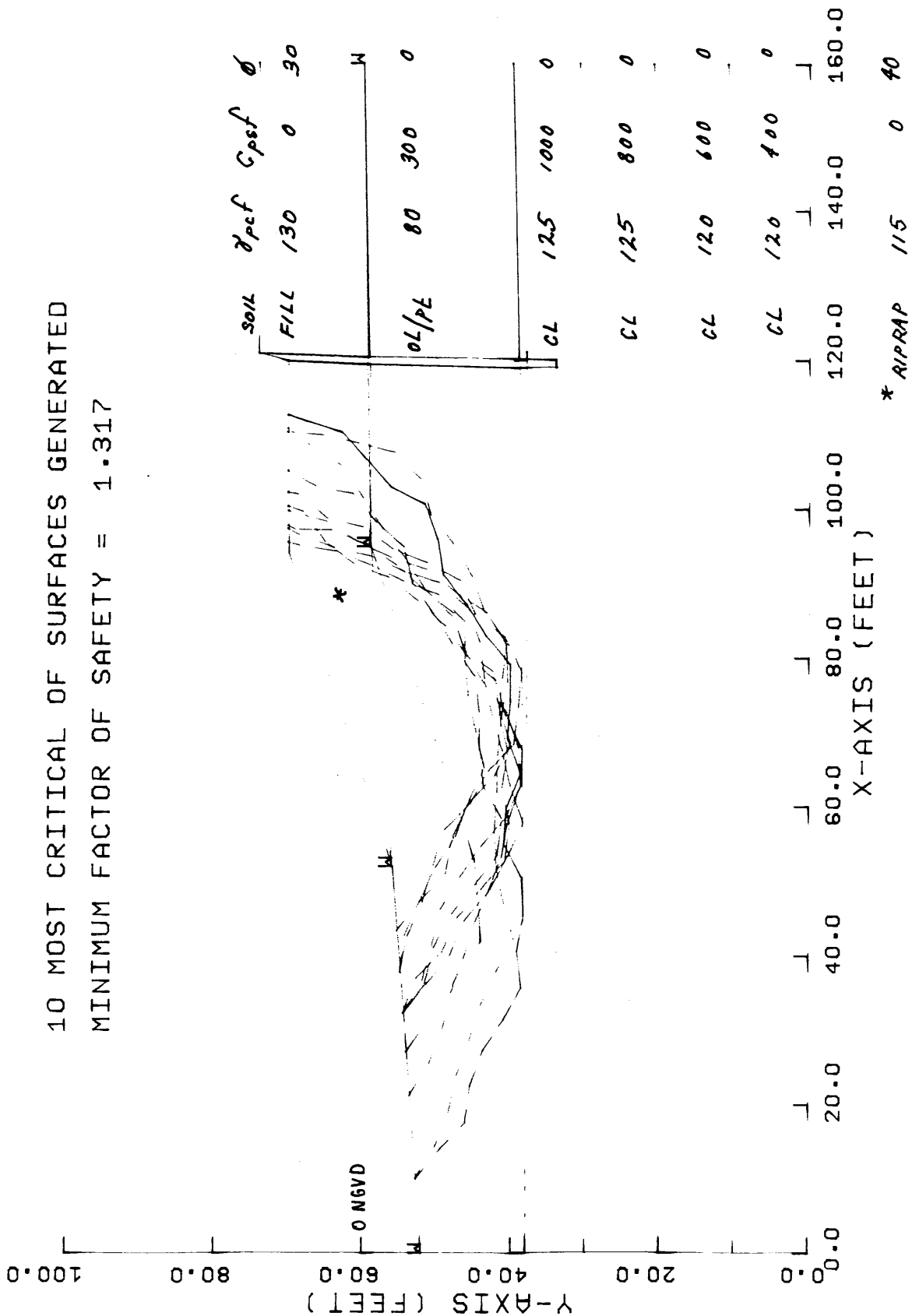


HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

FIGURE

FILE NO. 10259.01

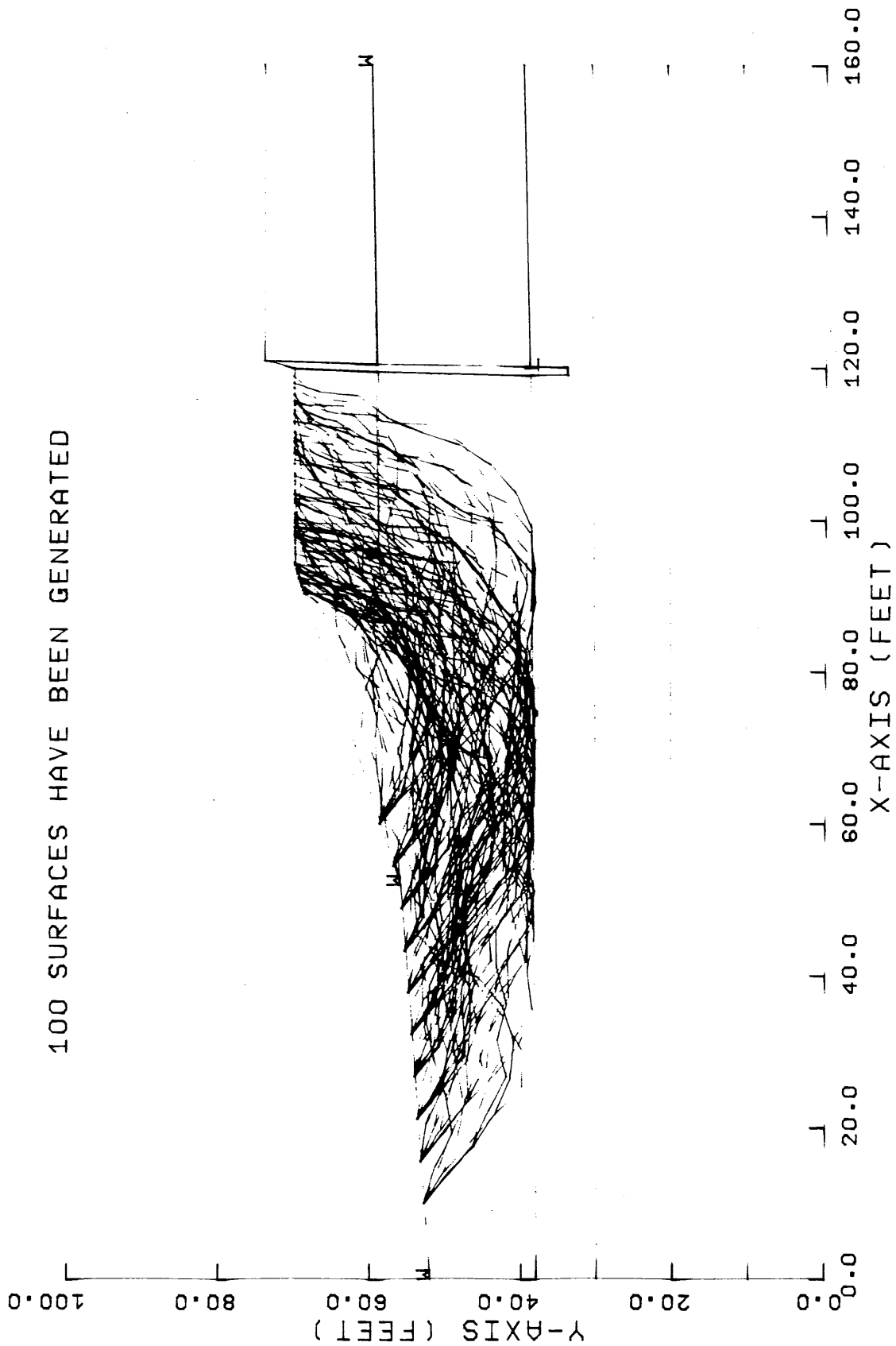
SECTION AT B89-4 10259



FILE NO 10259.01

SECTION AT B89-4 10259

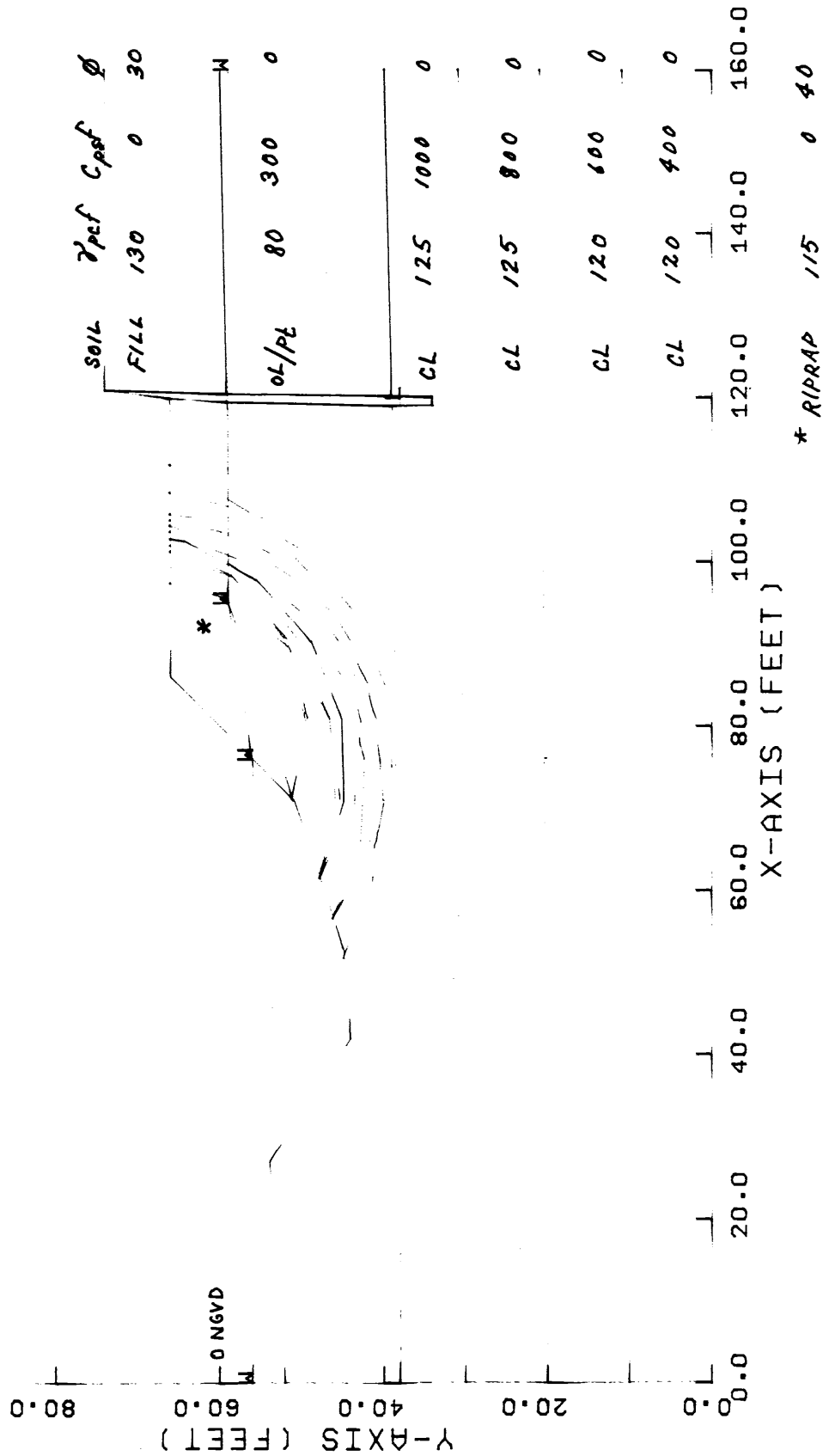
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FILE NO. 10259.01

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

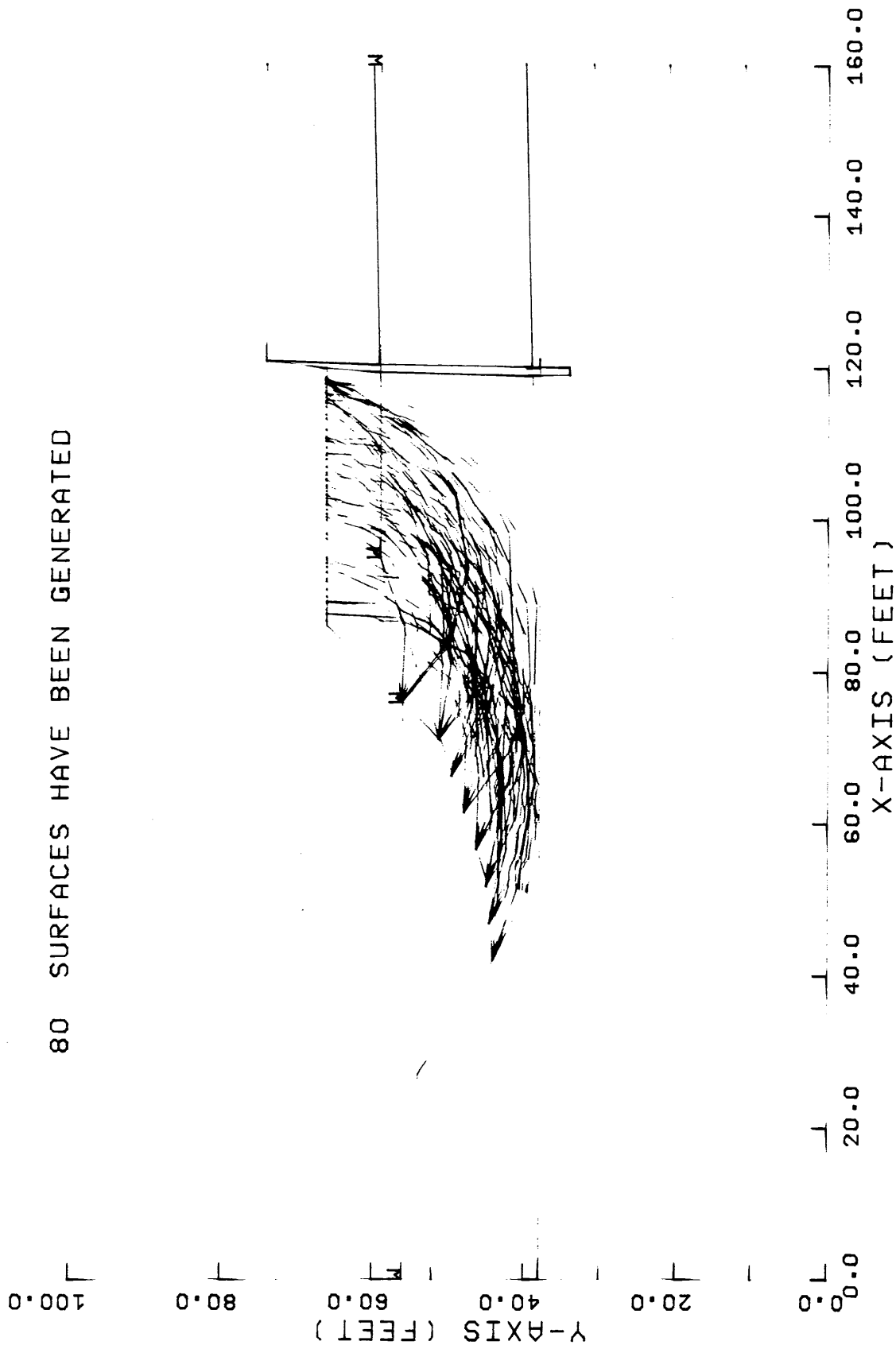
10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 1.156



FILE NO 10259.01

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

80 SURFACES HAVE BEEN GENERATED

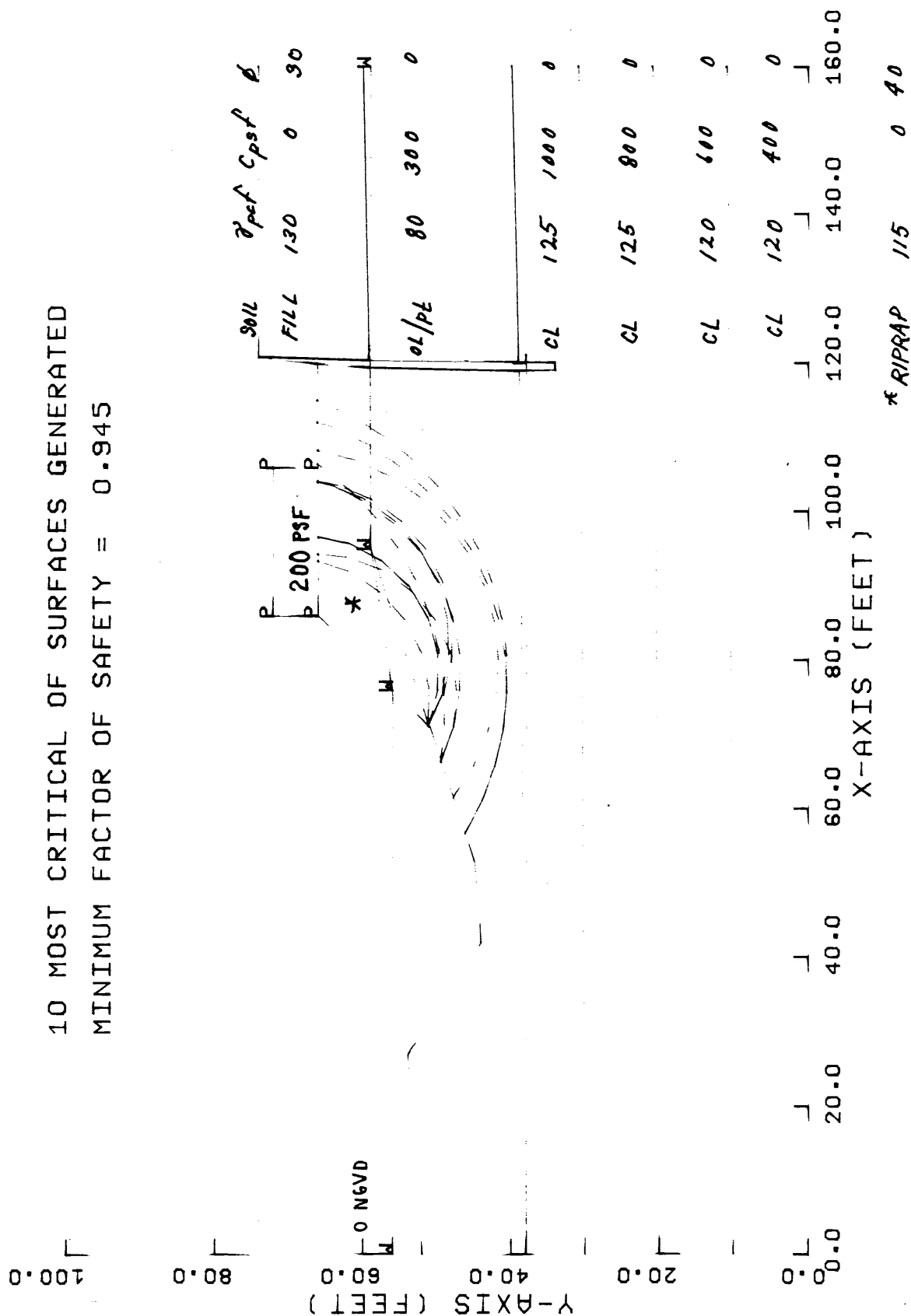


HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

FIGURE

SECTION AT B89-4, CONSTRUCTION OF
WORKING BERM 10259

10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 0.945

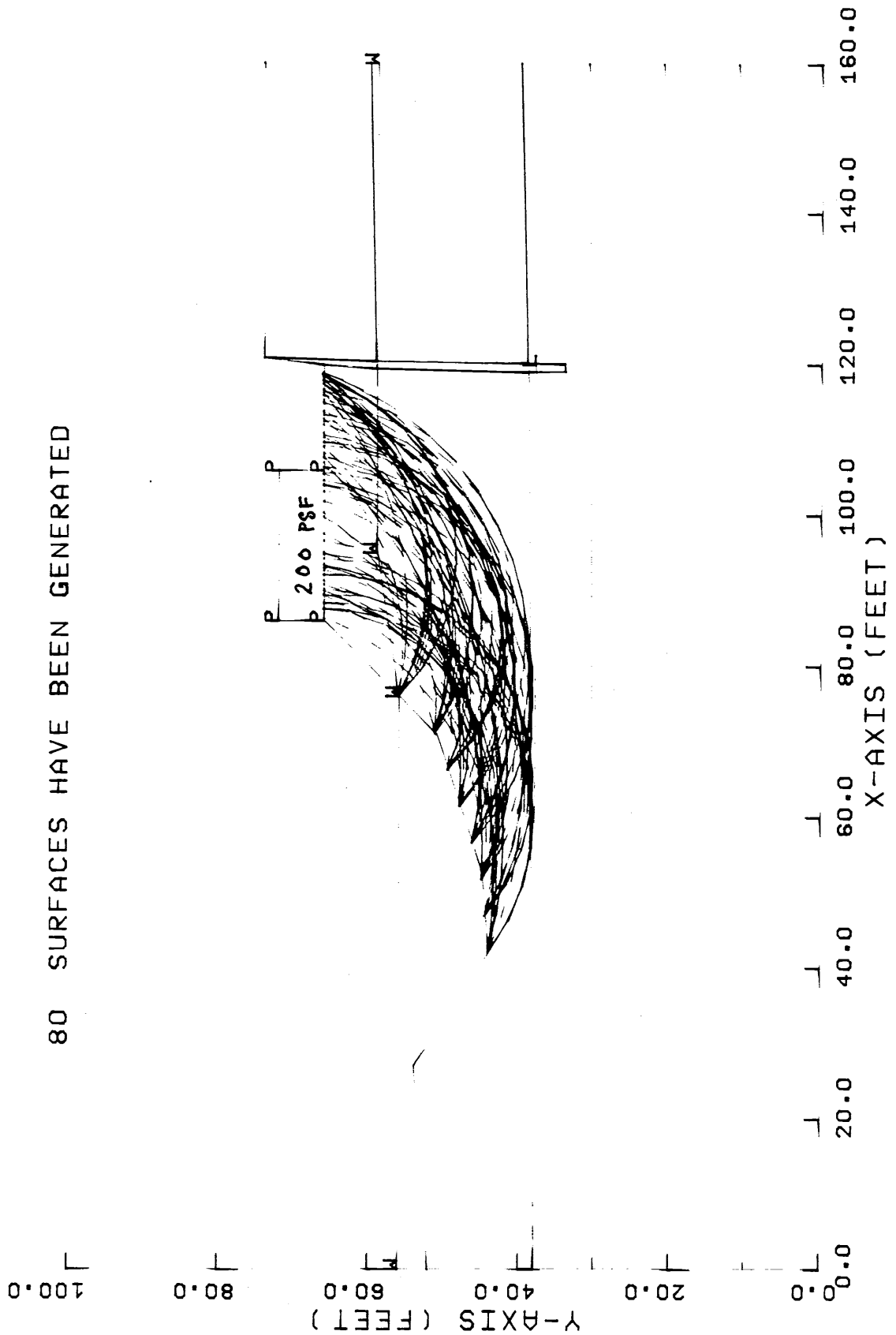


FIGURE

FILE NO. 10259.01

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

80 SURFACES HAVE BEEN GENERATED

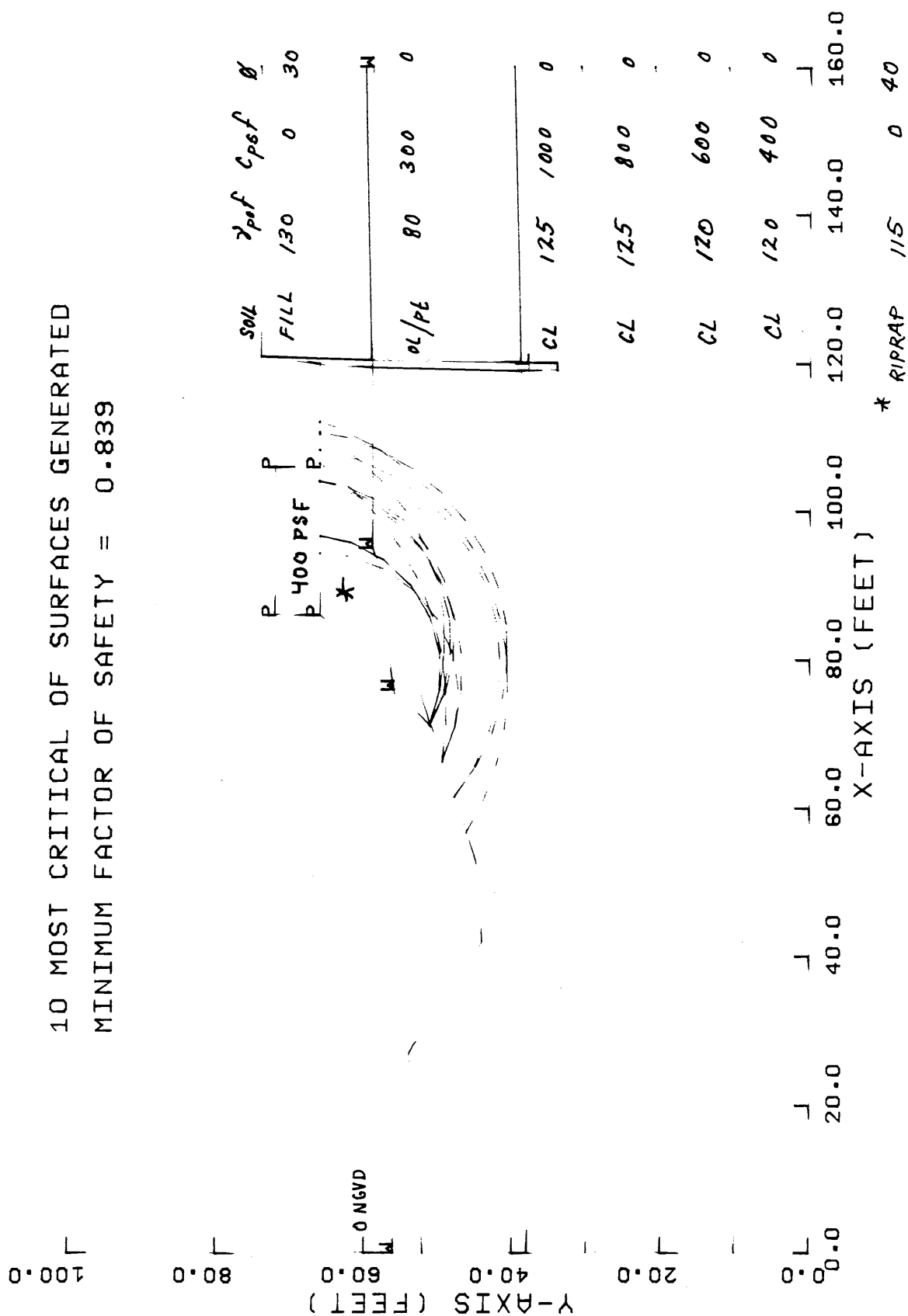


HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

FIGURE

SECTION AT B89-4, CONSTRUCTION OF
WORKING BERM 10259

10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 0.839



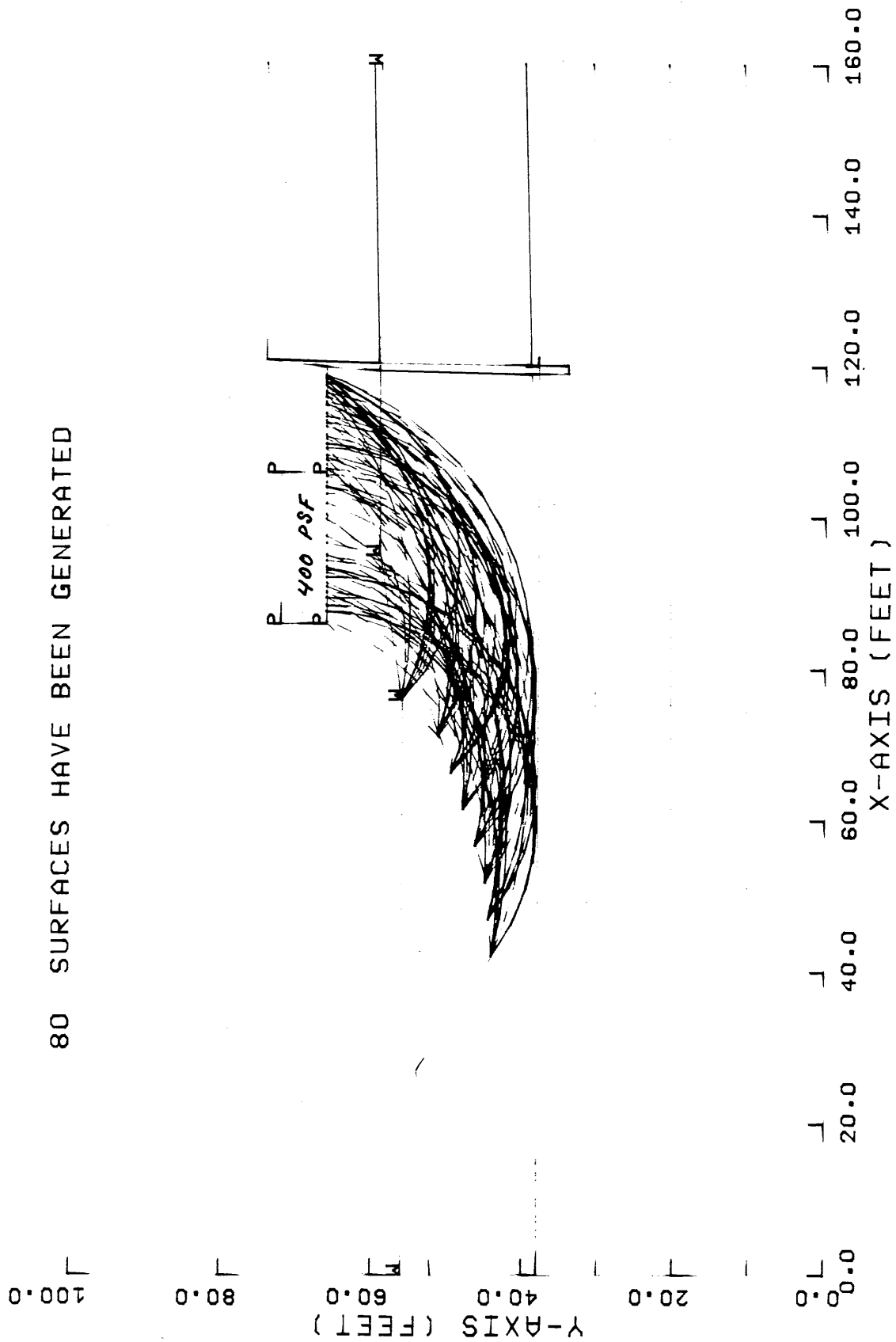
HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

FIGURE

FILE NO /0259.0/

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

80 SURFACES HAVE BEEN GENERATED



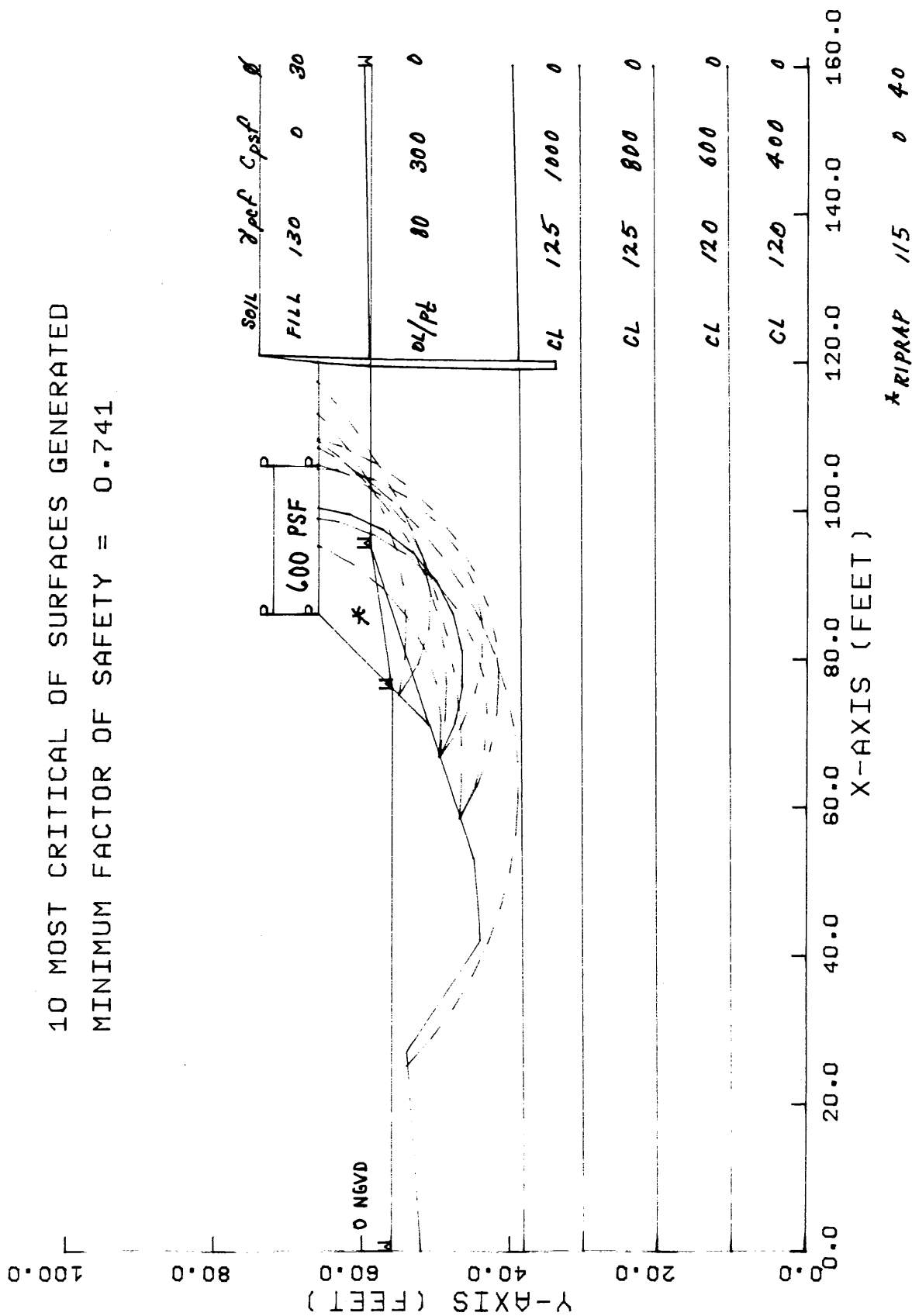
HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

FIGURE

FILE NO 10259.01

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 0.741



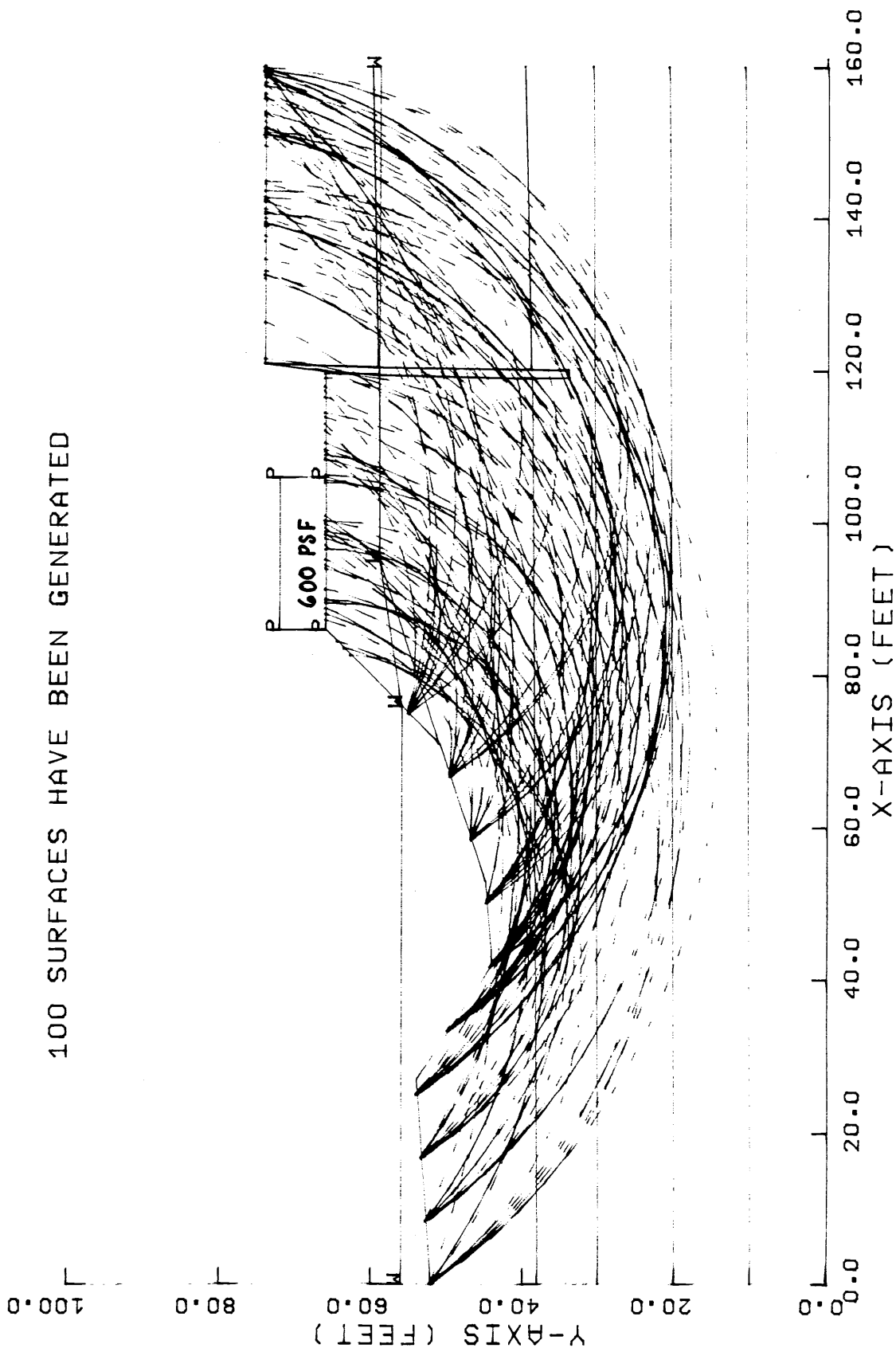
HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

FIGURE

FILE NO /0259.0/

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

100 SURFACES HAVE BEEN GENERATED

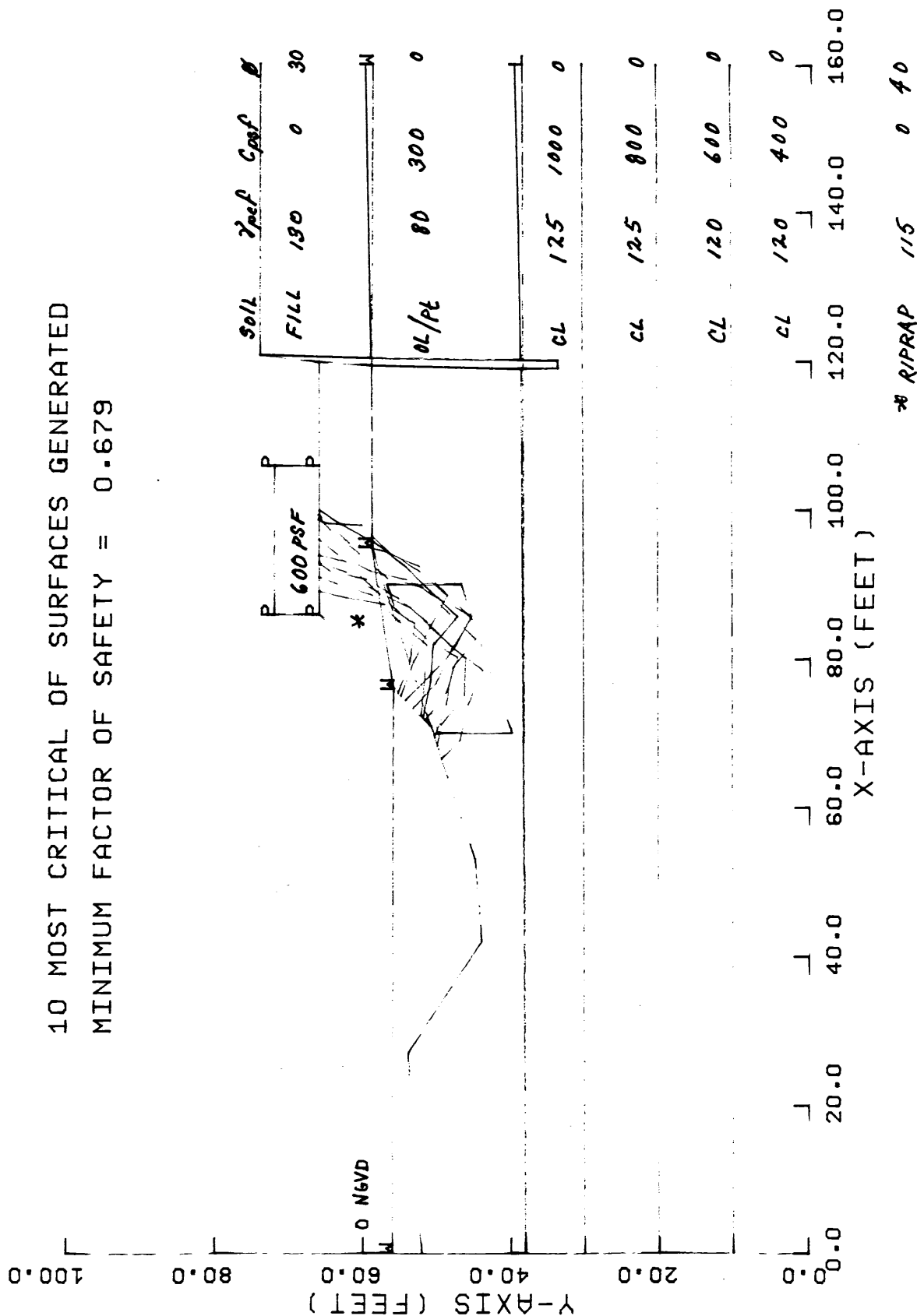


HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

FIGURE

SECTION AT B89-4, CONSTRUCTION OF
WORKING BERM 10259

10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 0.679

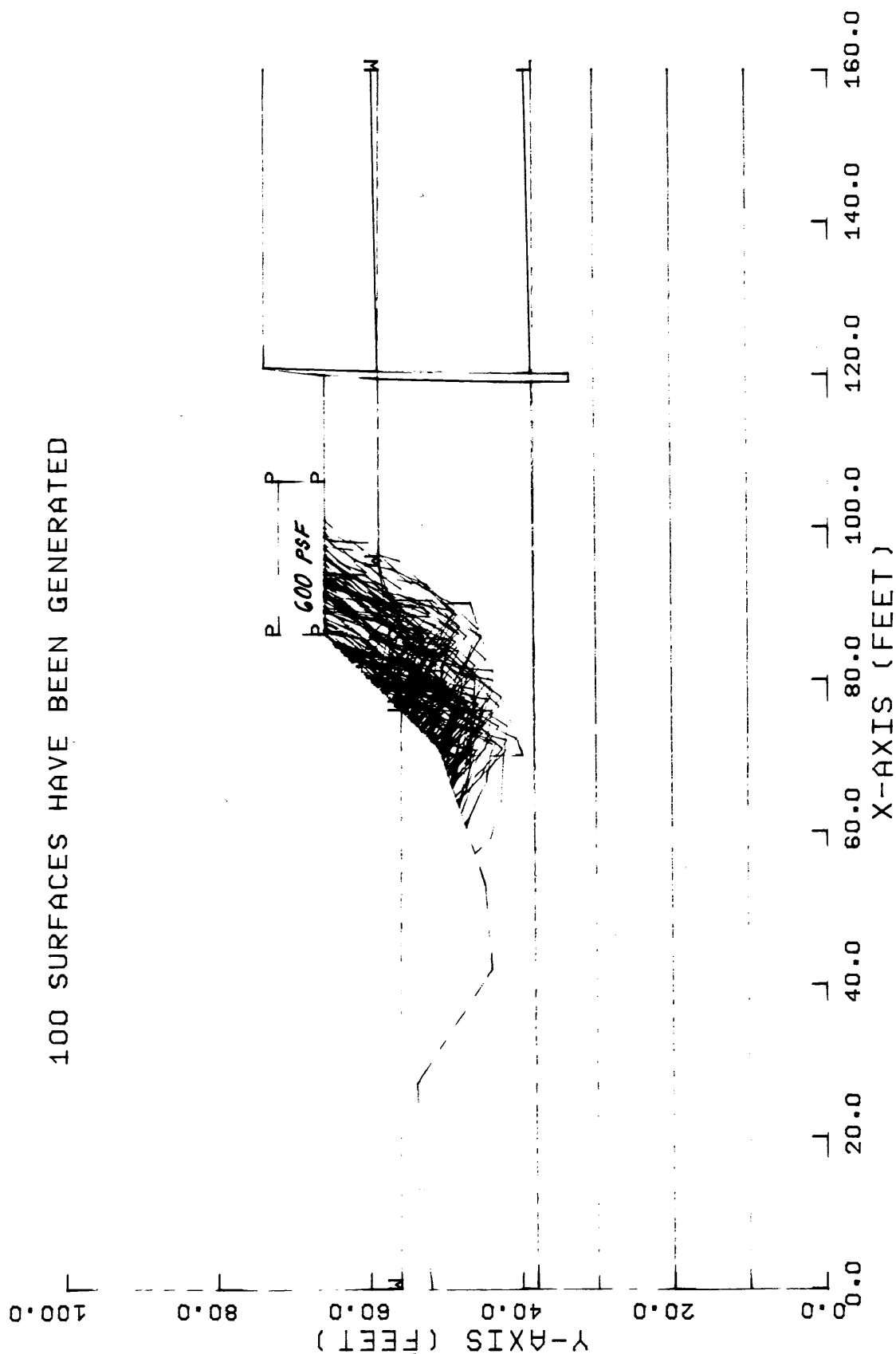


FIGURE

FILE NO 10259.01

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

100 SURFACES HAVE BEEN GENERATED

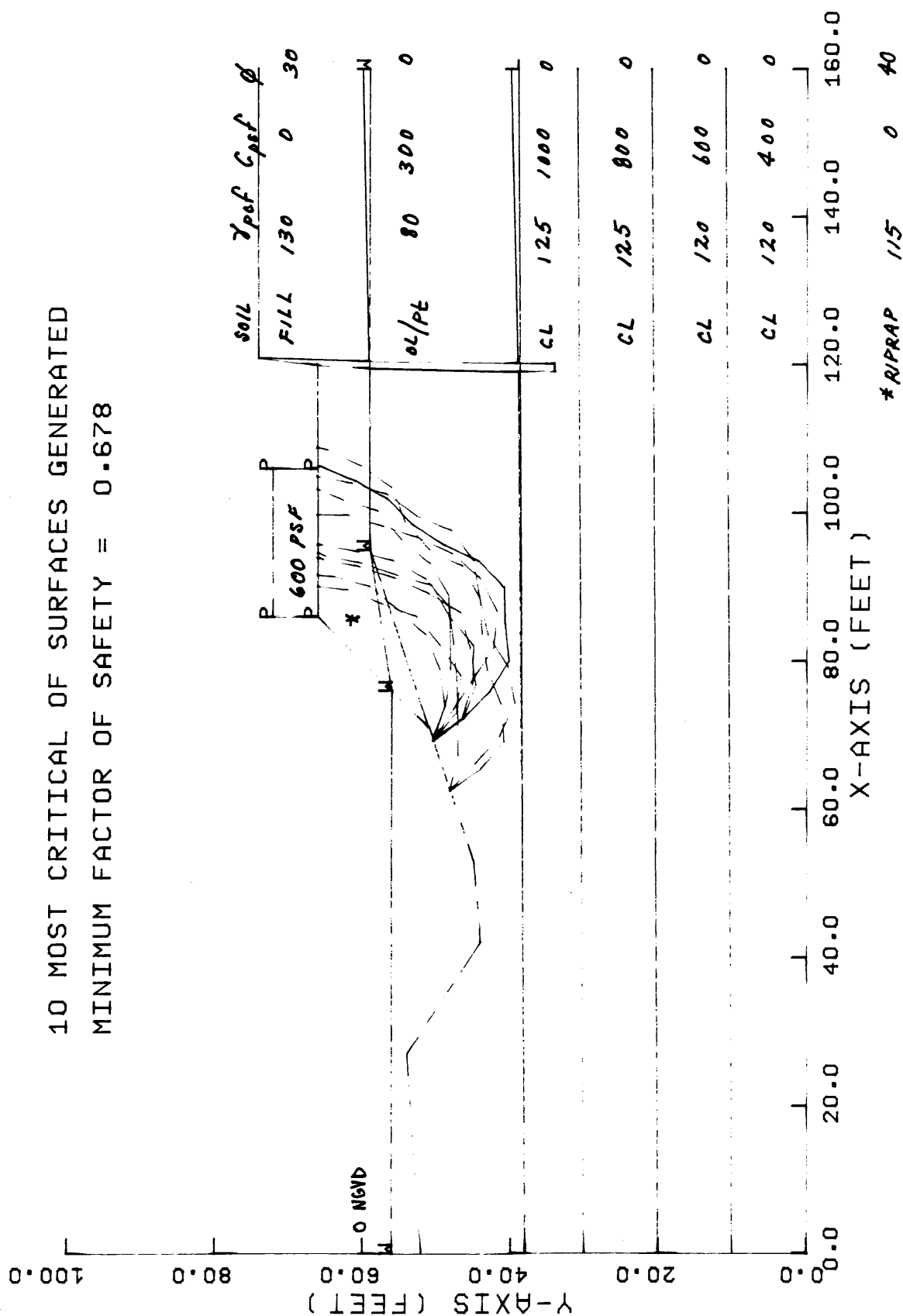


HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

FIGURE

SECTION AT B89-4, CONSTRUCTION OF
WORKING BERM 10259

10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 0.678

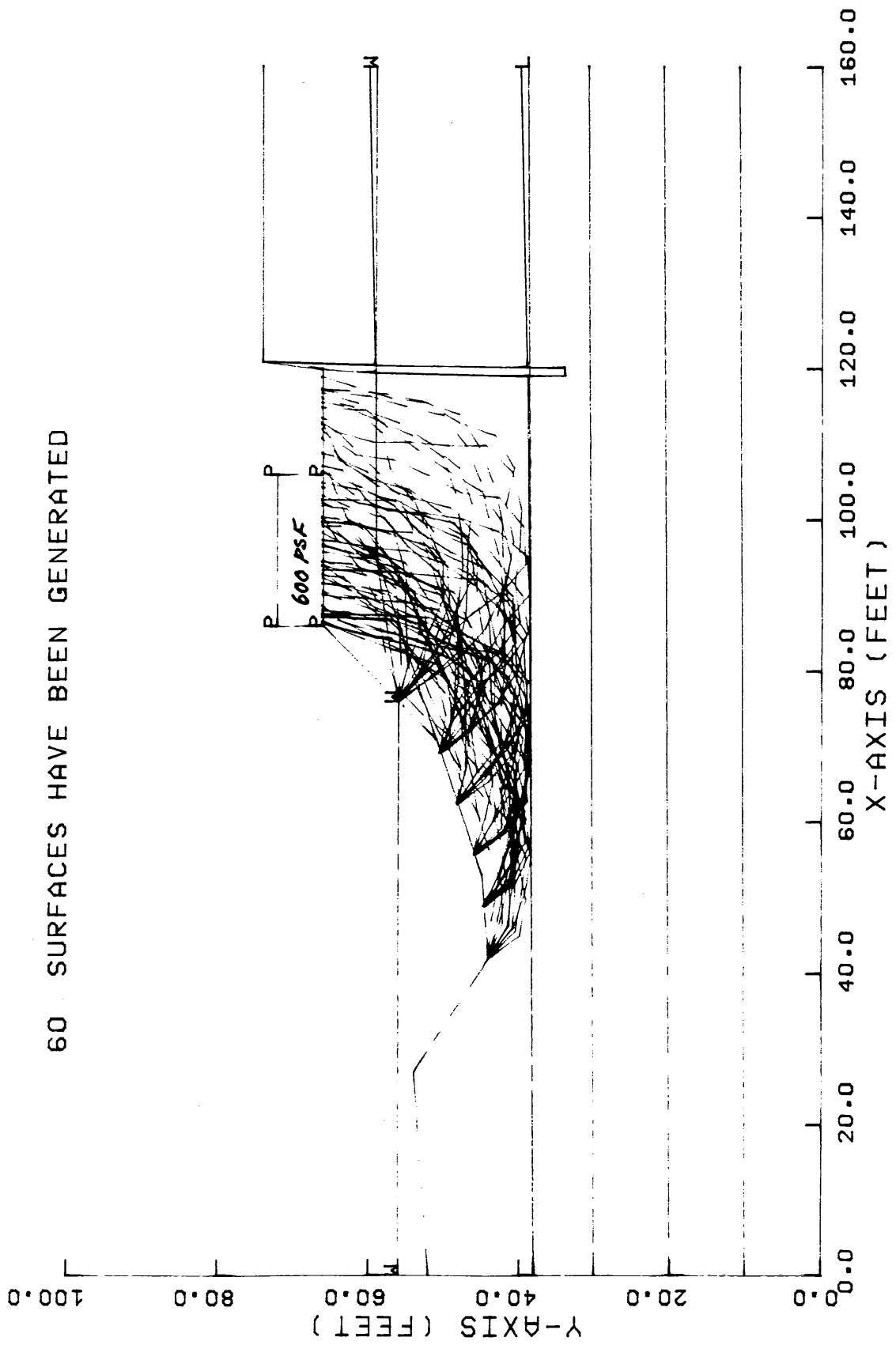


FIGURE

FILE NO 10252.01

SECTION AT B89-4, CONSTRUCTION OF WORKING BERM 10259

60 SURFACES HAVE BEEN GENERATED

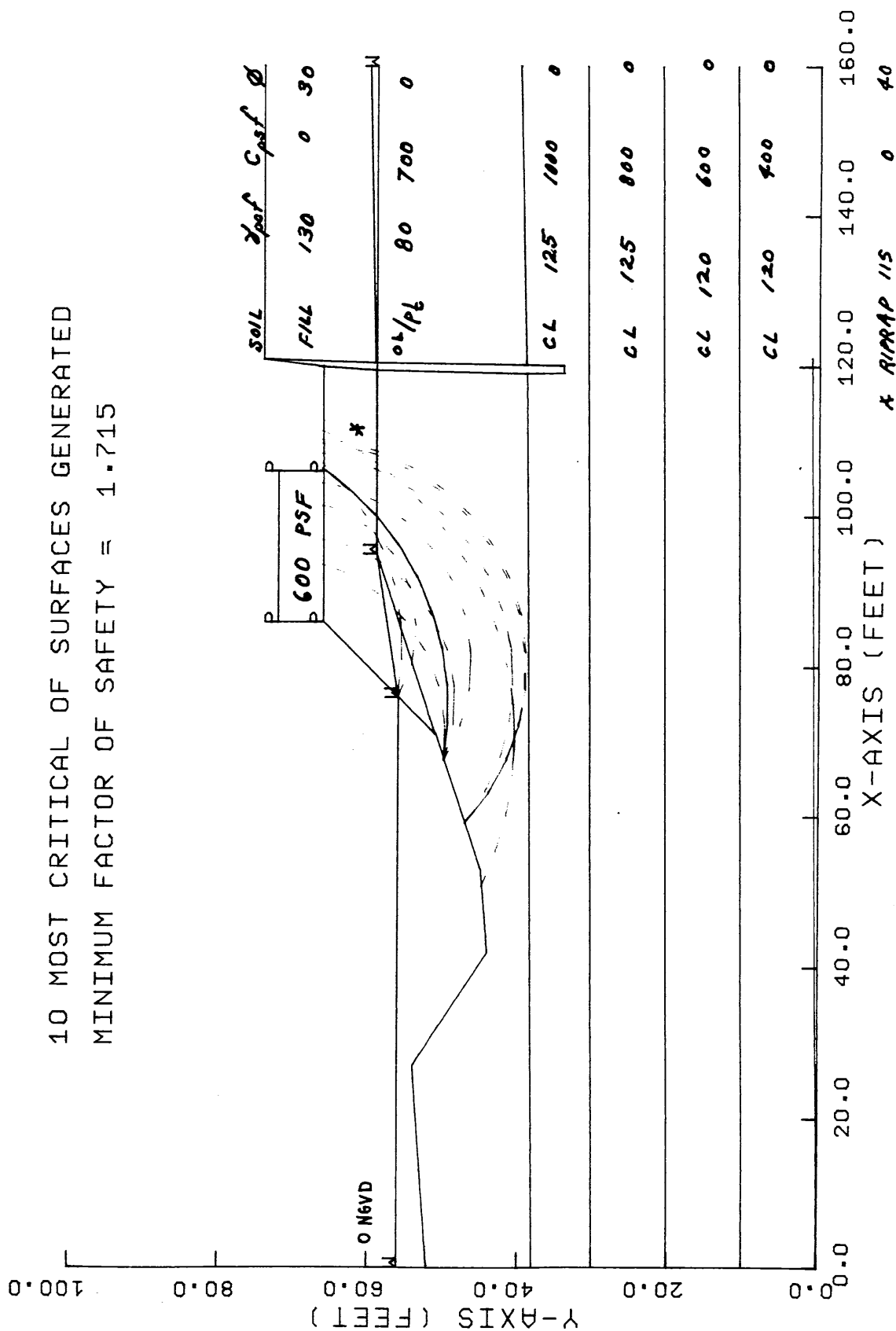


HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS

FIGURE

SECTION AT B89-4, CONSTRUCTION OF
WORKING BERM 10259

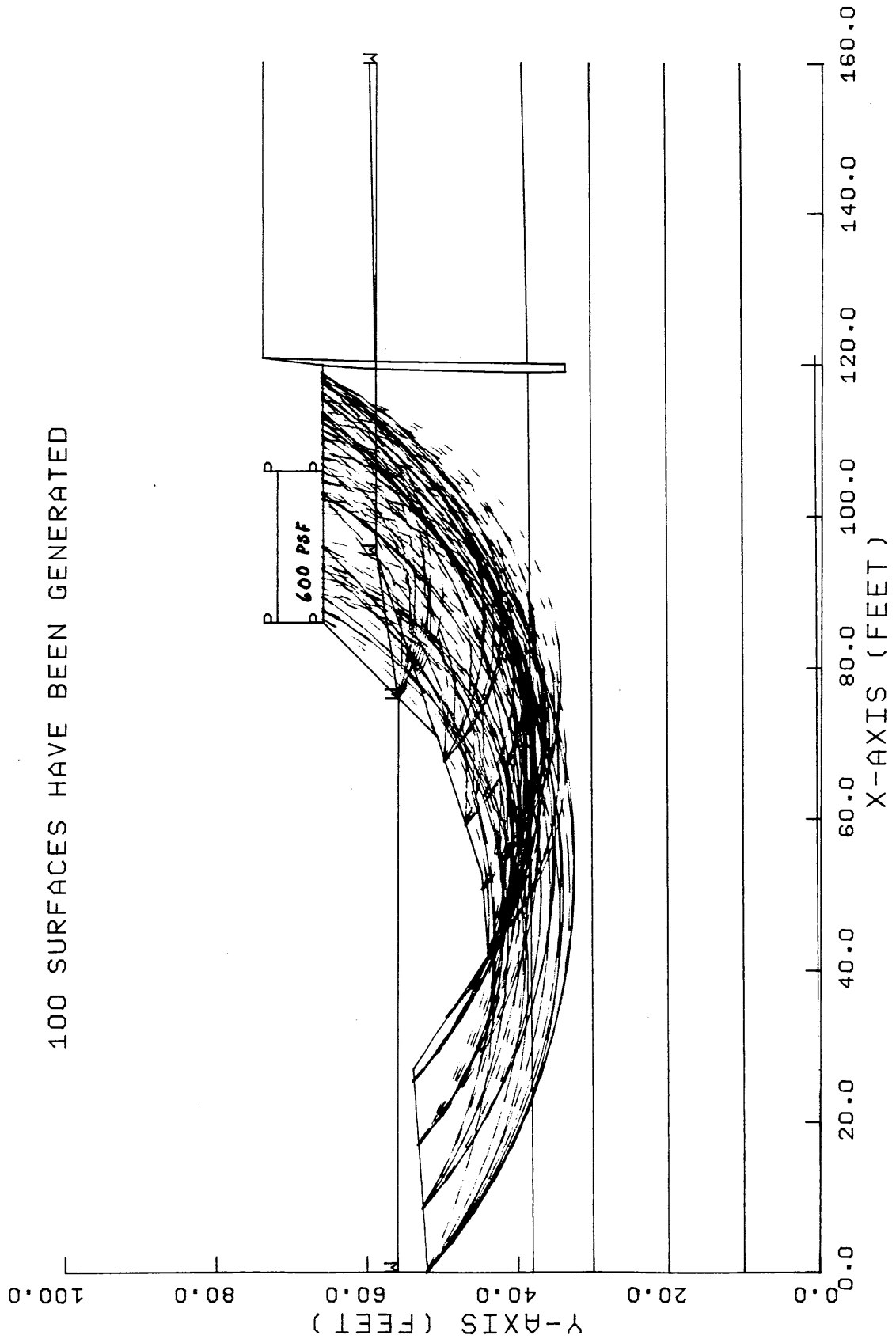
10 MOST CRITICAL OF SURFACES GENERATED
MINIMUM FACTOR OF SAFETY = 1.715



FIGURE

SECTION AT B89-4, CONSTRUCTION OF
WORKING BERM 10259

100 SURFACES HAVE BEEN GENERATED



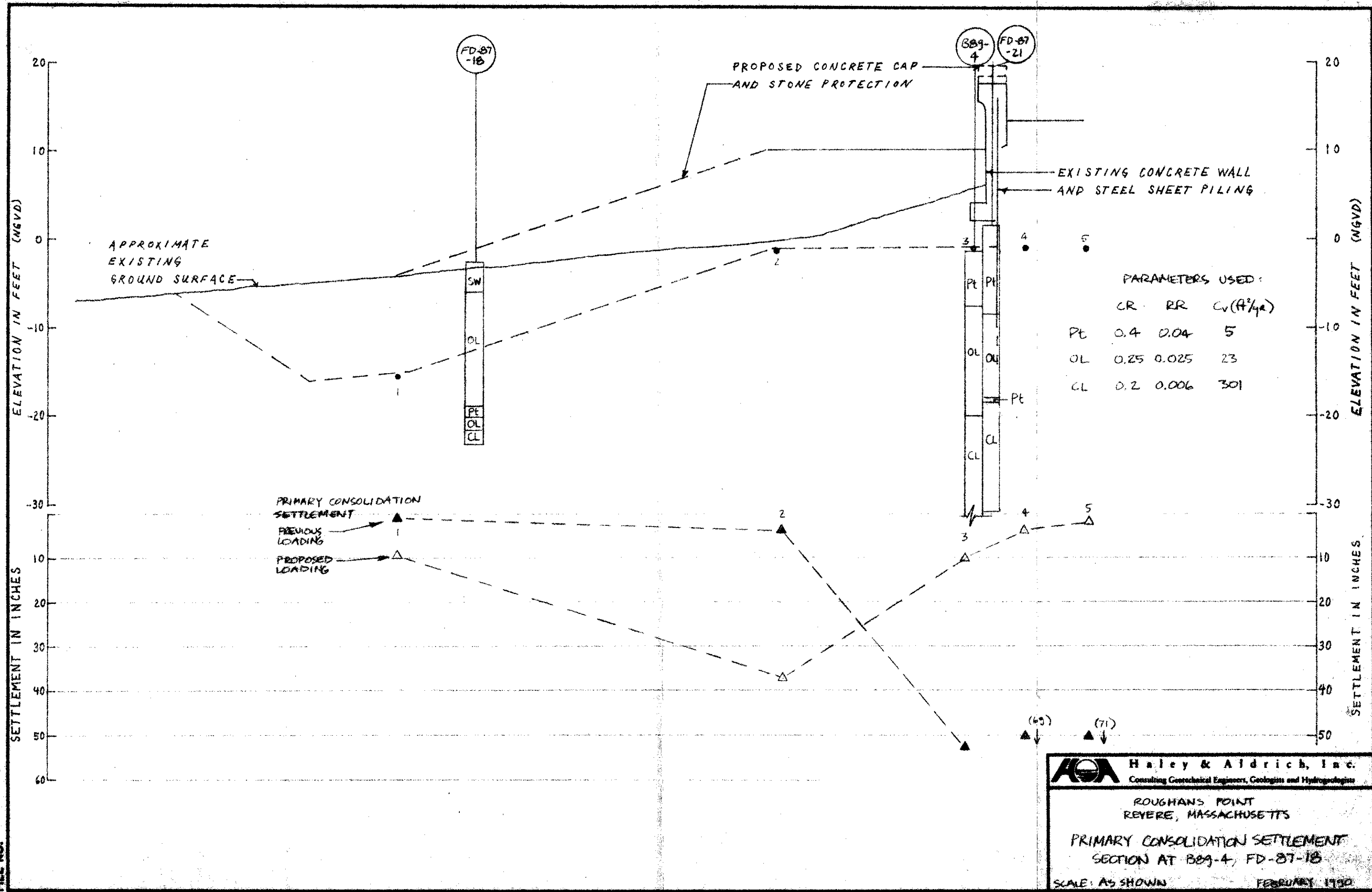
FILE NO

HALEY & ALDRICH, INC.
CAMBRIDGE, MASSACHUSETTS


FIGURE

APPENDIX F
Plotted Results of Settlement Analyses

FILE NO. 10259.01



CHARRETTE

**Haley & Aldrich, Inc.**
Consulting Geotechnical Engineers, Geologists and Hydrogeologists

ROUGHANS POINT
REVERE, MASSACHUSETTS

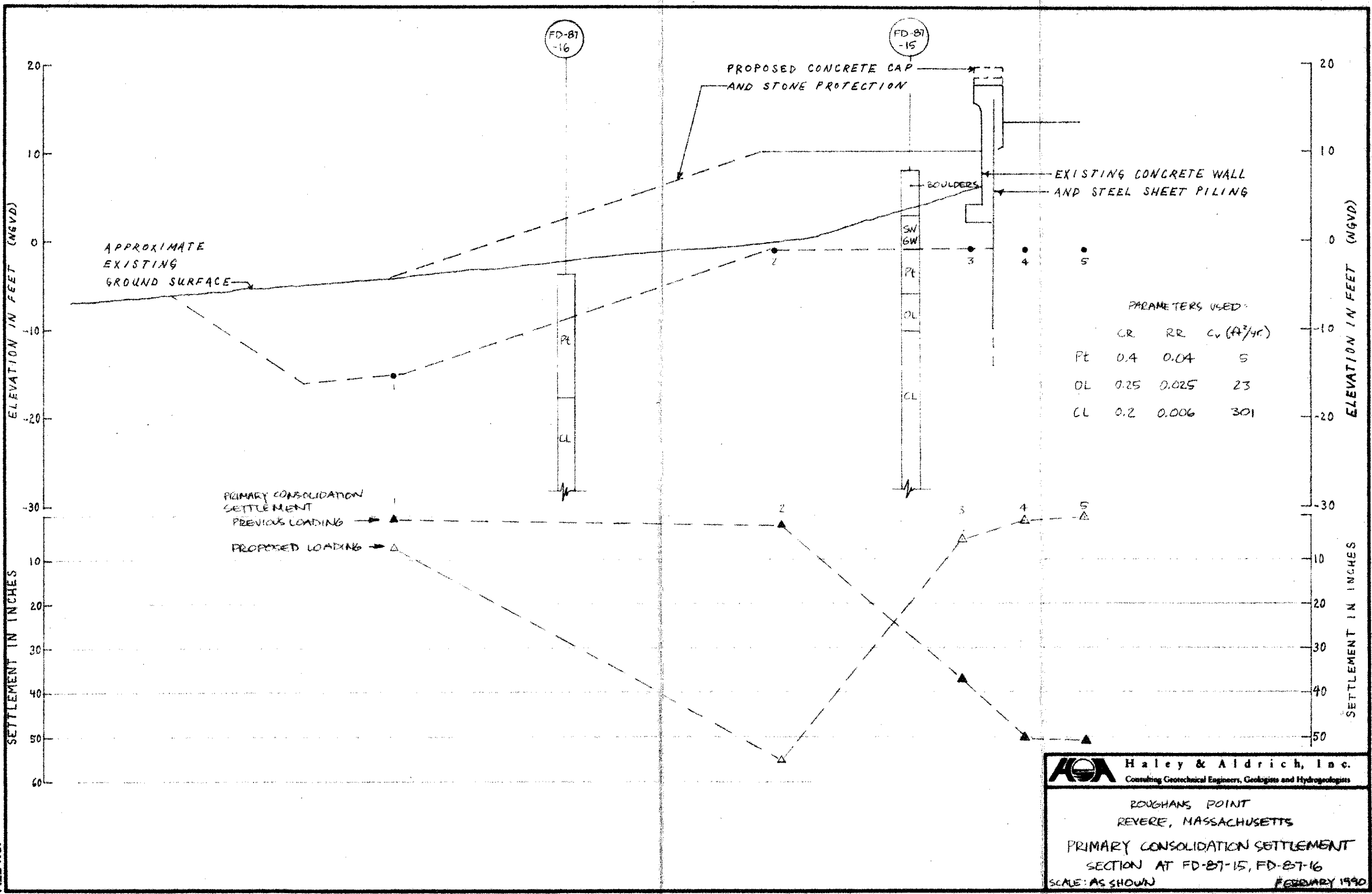
PRIMARY CONSOLIDATION SETTLEMENT
SECTION AT B89-4, FD-87-18

SCALE: AS SHOWN

FEBRUARY 1990

FIGURE P-1

FILE NO. 10259.01

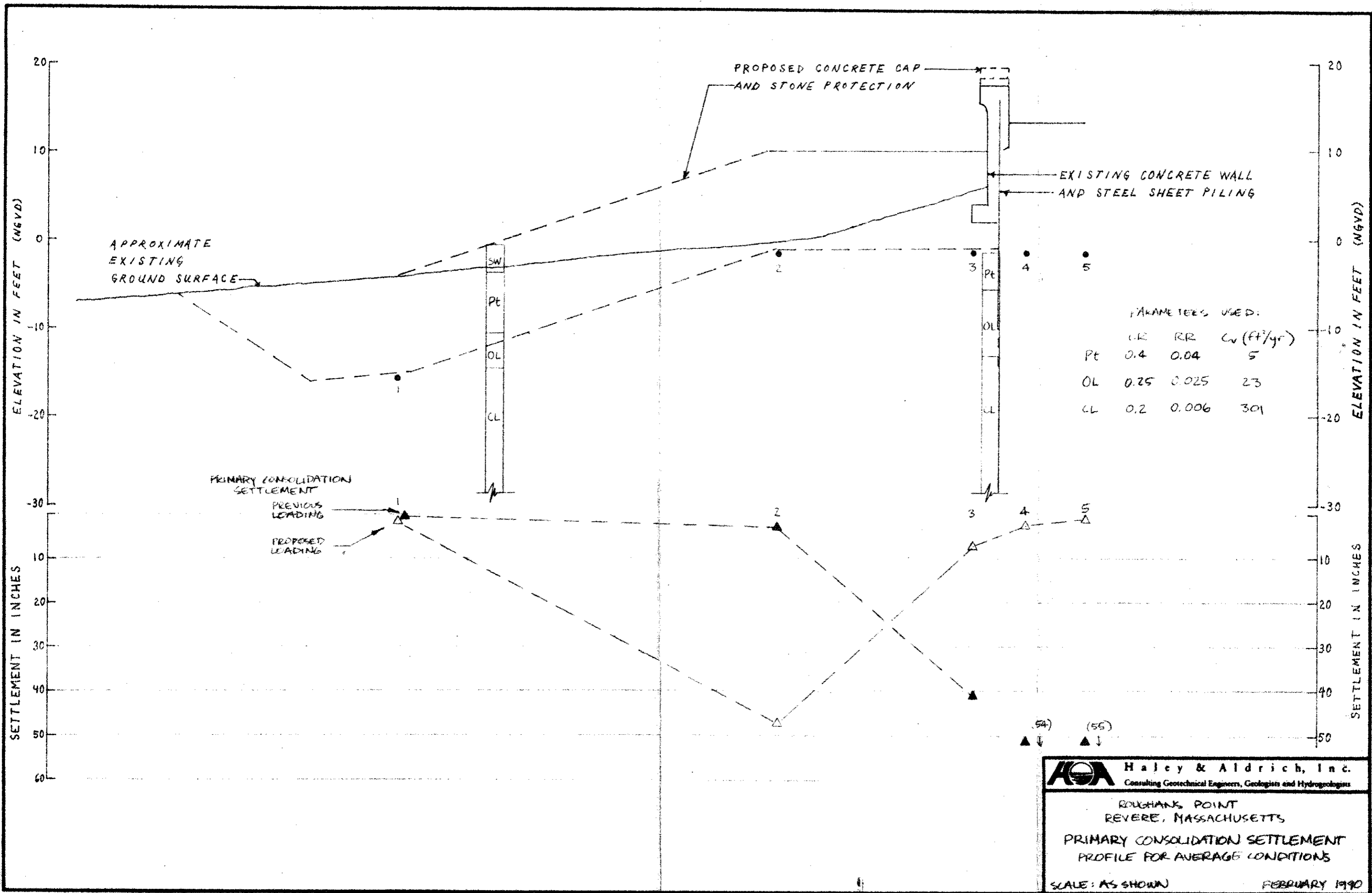


HA Haley & Aldrich, Inc.
Consulting Geotechnical Engineers, Geologists and Hydrogeologists

ROUGHANS POINT
REVERE, MASSACHUSETTS
PRIMARY CONSOLIDATION SETTLEMENT
SECTION AT FD-87-15, FD-87-16
SCALE: AS SHOWN
FEBRUARY 1990

FIGURE F-2

FILE NO. 10259.01



CHARRETTE

FIGURE F-3